BRITISH
FRESH-WATER ALGÆ.

VOL. I.

BRITISH

FRESH-WATER ALGÆ.

EXCLUSIVE OF

DESMIDIEÆ AND DIATOMACEÆ.

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VOL. I. TEXT.

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BRITISH FRESH-WATER ALGÆ.

INTRODUCTION.

"Fresh-Water Algæ" is confessedly an artificial arrangement which demands apology, but can scarcely receive justification. The only excuse which can be offered is, that it serves the purpose of those for whom the present work was written, namely, the Microscopists who desire some acquaintance with the organisms met with in their excursions to ponds and ditches. For the absolutely scientific algologist it will only be fragmentary, although it is by no means a solitary instance in which the Fresh-Water Algæ have been made the sole subject of a book, to the exclusion of marine species. Indeed, the restriction of Harvey's "Phycologia Britannica" to marine algæ, with but very few exceptions, left at least an excuse for attempting to supply the deficiency.

The historical portion of this introduction may be speedily summarized by dividing it into three epochs of about forty years each, the first being limited by the publication of Dillwyn's "Confervæ," the second by Hassall's "Fresh-Water Algæ," and the third by the present work.

Prior to the first epoch there were but two works of sufficient importance to be mentioned here, Ray's "Synopsis," which was published in 1724, and Dillenius' "Historia Muscorum" in 1741. Each of these, as far as they can be identified, included somewhere about twenty species of Fresh-Water Algæ.

The epoch commences in reality with Hudson's "Flora Anglica," the first edition of which is dated 1762, and contains about 25 species. Then came the first Edition of Withering's "Arrangement of British Plants" in 1776; Lightfoot's "Flora Scotica" in 1777, also with 25 species; Robson's "British Flora" in the same year, with 26 species; the second Edition of Hudson's "Flora Anglica" in 1778; Relhan's "Flora Cantabrigensis" in 1785, with 12 species; and Sibthorp's "Flora Oxoniensis" in 1794, with 7 species. This brings us to the third Edition of Withering in 1796, with 38 species; followed by Abbot's "Flora Bedfordiensis" in 1798, with 14 species; and Hull's "British Flora" in 1799, with 34 species. These were all the predecessors of Dillwyn, and did not achieve much for the Fresh-Water Algæ until the climax was attained by the publication of Dillwyn's "British Confervæ" in 1809, with 88 species enumerated. The first Edition of "English Botany" had already commenced in 1790, extending to 1814, but it was not until after the appearance of Dillwyn's work that the Algæ of the British Botany were published, ultimately including about 100 species. Undoubtedly Dillwyn was therefore the parent of a systematic study of the British Fresh-Water Algæ, and with him the first epoch culminated.

The second epoch commenced well with the continuance of "English Botany," and then followed several Botanists whose influence has passed down even to our own times. Following the example of the first epoch, we may enumerate the most important of their works. The "Midland Flora" of Purton in 1821 only includes about 14 species. Hooker's "Flora Scotica" in 1821 about 39 species; Gray's "Arrangement" in 1824, was confessedly devoted chiefly to systematic classification, including nominally 103 British Fresh-Water Algæ. Greville's "Flora Edinensis" in 1824 had 50 species, the working period for Algæ having scarcely commenced, his "Algæ Britannicæ" appearing in 1830. Jones and Kingston's "Flora Devoniensis" in 1829 included but 29 species. Johnston's "Flora of Berwick-on-Tweed" in 1831 had 40 species. Near this time (1833) Berkeley's "Gleanings of British Algæ" was published. The latter volumes of "The English Flora" appeared also in 1833, under the editorship of Sir William Hooker, the Algæ being contributed by Dr. W. H. Harvey, and included 160 species. This was Harvey's first important contribution to the History of British Algæ, which was succeeded in 1841 by the first Edition of his "Manual," containing 198 fresh water species. Between these two Mackay's "Flora Hibernica" was issued in 1836, with 87 Irish species. These all culminated, in 1845, in the appearance of Hassall's "Fresh-Water Algæ," enumerating 297 species, exclusive of Characeæ, Desmidiaceæ, and Diatomaceæ, thus closing the second epoch. The time at which this latter work appeared was an active one in British Fresh-Water Algæ. Ralfs was preparing his work on Desmids, and contributing papers to the scientific journals, notably the "Annals of Natural History." Dr. Greville had commenced his "Scottish Cryptogamic Flora" in 1823. Harvey was at work earnestly with Marine, and of course casually with Fresh-Water Algæ. The volume containing the Algæ of the "English Botany," second Edition, appeared in 1844, so that about this time, which we distinguish as the end of the second epoch, characterised by the publication of Hassall's work, there was greater promise than came to be realized in the early part of the next epoch.

It is not uncommon to hear observations made disparagingly of the work with which the second epoch closed, when no account is taken of the difficulties which had to be encountered in preparing an illustrated work of that nature. It cannot be fair to judge it by its successors, but by its predecessors, and if it was fairly up to the general standard at the time of its production, that is all we can expect. It must be remembered that Kutzing's large and splendid work, the "Tabulæ Phycologiæ," was only commenced in 1846, and that therefore it could not be consulted. It is certainly to be regretted that in Hassall no indication is given of the measurement of the objects figured, or the magnification employed. That there are faults no one will deny; but, on the whole, we are not prepared to condemn it as unworthy of the time at which it appeared. A comparison of the Desmids with those in Ralfs' work, of but three years later, will show that in *execution* something was left to be desired.

The third epoch is one on which we must necessarily be very brief; coming so near our own time we must be content to indicate what has been done, and leave conclusions to others. Closer relations with the Continent, cheap postage, more general acquaintance with foreign works, all tend to raise greater expectations for the closing work of the third epoch than of its predecessors. The works of Kutzing, the Memoirs of Pringsheim, De Bary, Cohn, Bornet, Thuret, Borzi, Wittrock, and many others, all contribute to illustrate British Fresh-Water Algæ; and although during forty years very little has been done in our own island, even in the identification of species, there has been considerable activity in investigation, especially in the North of Europe. The scattered memoranda, notes and observations of Professor Henfrey, Dr. Braxton Hicks, and Mr. W. Archer constitute the bulk of our home manufacture of the literature of Fresh-Water Algæ for about 30 years. The later portions of the "Supplement to English Botany," containing Algæ, date from 1843; and Harvey's second Edition of the "Manual," in 1849, was wholly confined to Marine species. Hence there is not an independent work on British Fresh-Water Algæ belonging to this third epoch, the only contributory work being Berkeley's "Introduction to Cryptogamic Botany," in 1857. But if there was an extraordinary dearth of books on this subject after 1845 in Britain, such was not the case on the Continent. The consecutive publication of the volumes of Kutzing's "Tabulæ" must have been an important influence, although it was not until 1864 that Rabenhorst's "Flora Europæa Algarum, Aquæ Dulcis et Submarinæ" was commenced. The advent of this work was hailed with pleasure, notwithstanding its many faults; and various authors set themselves to work on different genera and families, such as Ædogoniaceæ, Zygnemaceæ, &c., so that in twenty years it is left far behind. As a work written in English, although not containing much original observation, we must mention Dr. Horatio Wood's "Fresh-Water Algæ of North America," published in 1872. The period selected, therefore, for a new work on the "British Fresh-Water Algæ" was in all respects opportune, but we are not expected to judge whether good use has been made of the opportunity.

The gradual accession to knowledge of the structure and development of Algæ, during the past century, would extend this chapter far beyond the limits we have assigned to it, whereas an intimation of the present position is generally indicated under the several groups, in the body of the work, with some reference to the sources of further information.

Classification must, of course, depend very largely upon investigation, and modifications necessarily follow new facts, so that, whilst adopting suggestions made by authors of recent monographs, our arrangement is not absolutely that of any other work, although as far as possible the orders and larger groups have not been disturbed. We will not venture to predict what will be the future of such families as the *Palmellaceæ*, *Protococcaceæ*, and *Chroococcaceæ* during the next twenty years; probably they will disappear altogether, becoming merged into other groups of which most of them may be demonstrated to be only imperfect conditions. At the present time we could follow no other course than to include them, and leave the future to take care of itself. We have preferred including too much to excluding too much, in confidence that for this we should be the more readily forgiven.

The student will expect to find in this place some practical hints to guide him in his pursuit, but these must be brief, as experience, combined with a little personal contact with old hands at field-work, will supersede a volume of precepts.

The habitats attached to the various species will indicate the kind of locality in which to search for them, but it may be remarked that, generally, any slow stream, pond, or standing pool will furnish something. Rapid currents will not repay the search. Small pools on moors, amongst *Sphagnum*, will usually prove prolific, and submerged plants, especially when dead or dying, often serve as a habitat for attached species. Damp rocks, down which the water trickles, old quarries, damp walls in greenhouses and hothouses, warm springs, outlets of warm water from steam engines, brackish ditches, all these have their own peculiar forms, and experience will soon prove that where the favourable condition of quiet humidity is found, search will seldom be in vain. Of course, during exceptionally dry weather localities which would otherwise give satisfaction may produce nothing but disappointment.

The methods of collecting do not much differ from those adopted for other kinds of pond life. A japanned case with from six to twelve corked test tubes will usually suffice for a day's collecting. Filamentous Algæ, such as *Spirogyra*, *Cladophora*, &c., may be wrapped singly in paper, and a number of these packets can be contained in a small tin box. It is always essential to keep each "gathering" by itself.

Preservation for future study, or for the herbarium, will be secured by the usual methods of floating and mounting marine Algæ, first cleansing the specimens by well washing in a flat dish or soup-plate, and finally passing under them a slip of clean white paper, which is raised so as to take up the Algæ in the middle, well floated into position, draining off the water, and then drying, with the least pressure possible. For minute species, and small specimens, thin flakes of mica are preferable to paper, for many reasons, especially that they can be placed at any time under the microscope and examined. The *Palmellaceæ*, and similar groups, will be of very little service if dried in any other way. Most species will adhere of themselves to either paper or mica, the exceptions, such as *Vaucheria* and some *Cladophoræ*, can be fixed with gum tragacanth.

Some difficulty may probably be experienced in mounting satisfactorily specimens for the microscope. We have seen "slides" in which the specimens were still green and life-like after having been mounted for twelve years in the water in which they were collected, but unfortunately there is always a risk of leakage with mounts in fluid. If the medium is denser than the contents of the Algæ cells, the endochrome will be contracted and the walls collapse. One objection to mounting in glycerine, or glycerine and water, is the density of the medium, and consequent collapse of the cells; another, that in time, use what precaution you may, the cells will leak, more or less, in the majority of instances. No medium has yet given us absolute satisfaction, but all things being considered, we are most favourably disposed towards glycerine jelly, which is too dense to enter the cells, and does not alter the form more than glycerine would do. We may add that the slides should always lie *flat* in the cabinet, and *not* on edge, and they should not be left exposed to the light, or the green colour will soon be lost.

Hints for cultivating in growing cells, or preservation in small aquaria, are scarcely necessary in these days of manipulation. Many forms of growing slides have been designed and described, each possessing some special advantage, and arrangements of common glass tumblers, communicating with each other by small syphons, or lax threads, will keep up a constant flow of water, sufficient to preserve Algæ living and thriving throughout the year. The life-history, changes, and development of many species still require to be patiently investigated, and for this purpose there are ample contrivances, all that is required being leisure, patience, and perseverance.

It can scarcely be necessary to insist on the presence of fructification, if a given species is to be accurately determined. This is especially the case in *Œdogoniaceæ* and *Zygnemaceæ*, but it applies also in a less degree to the majority of families. The great difficulty that is experienced in determining, with any approximation to accuracy, many of the species described by authors half a century ago, lies in the insufficiency of the characters of the fructification. A large number of species of *Œdogonium*, for instance, as recent as Hassall's work, cannot be definitely placed on account of this insufficiency. This may at the same time serve as a caution to the inexperienced, that it will be worse than useless attempting to affix a name to specimens collected in a young or imperfect condition, at any rate in genera the fructification of which is known, and embodied in the generic and specific characters.

Although it can hardly be considered essential to allude in this place to theories which have been propounded in connection with Fresh-Water Algæ, we may make a passing allusion to the suggestion that sexually distinct filaments exist in the

Zygnemaceæ, and meet it by the assertion that, as far as our experience goes, this suggestion is not supported, and the evidence produced is far from satisfactory. The larger and more complex hypothesis of the combination of Algæ and Fungi in the production of Lichens, has been combated elsewhere,* and to this we have nothing to add, save that we have since encountered no facts or arguments which would induce us to modify that opinion. Even should hereafter the terrestrial Nostocs be united with the *Collemaceæ*, the saxicolous *Stigonemeæ* be relegated to the *Sirosiphei*, and the corticolous *Chroolepidæ* be transferred to some other relationship, the true aquatic Algæ would still remain in sufficient number to interest the student, and maintain for some time to come the distinctive group of Fresh-Water Algæ.

* "Grevillea," Vol. vii., p. 102.

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FRESH-WATER ALGÆ.*

Algæ are usually associated under five classes, which are taken in variable order, according to the judgment of the author, and may thus be enumerated :—

I. Chlorophyllophyceæ, with the cell contents mostly of a chlorophyll green.
II. Phycochromophyceæ, with the cell contents mostly of a bluish green.
III. Melanophyceæ, with the cell contents olive, brownish, or blackish.
IV. Rhodophyceæ, with the cell contents rosy, purple, crimson or violet.
V. Diatomophyceæ, with an incombustible siliceous skeleton.

Other arrangements have been proposed, but the above will answer for all practical purposes. The third class are all marine, and the majority of the fourth, so that, exclusive of Diatoms, which are a special study, the fresh water Algæ are mainly included in the first two classes.

Class I. CHLOROPHYLLOPHYCEÆ.

Plants aquatic or aërial, one, or two, or many-celled, either single or associated in families. Either branched or simple. Cell wall not siliceous but combustible, sometimes composed of successive layers, or strata, of a gelatinous substance. Cell contents chlorophyllose, sometimes crimson, flesh-coloured or reddish-brown, often with a central or lateral nucleus. Starchy granules very rare. Vegetation by cell division. Fecundation often sexual. Propagation either by oospores or zygospores or gonidia, which are motionless or agile (*zoogonidia*).—*Rabh. Alg.* iii. *p.* 1.

* Exclusive of Desmidieæ and Diatomaceæ.

ORDER I. *COCCOPHYCEÆ.*

Unicellular algæ. Cells either single, or many associated in families, tegnment involute or naked, destitute of branches or terminal vegetation. Propagation by cell-division or zoogonidia.

This order includes the two families *Palmellaceæ* and *Protococcaceæ*, with unmoveable cells, to which is attached a third, the *Volvocineæ*, with mobile cells. The two former correspond to the *Chroococcaceæ* amongst the class *Phycochromaceæ*. Although thus removed, it would seem from recent researches, that there is, in some sort, a relationship between the *Palmellaceæ* and *Protococcaceæ* on the one hand, and the *Chroococcaceæ* on the other.

We can only direct attention here to the papers by P. Richter, in "Hedwigia,' (xix., 1880, p. 154) on *Glæocystis* and (xix. 1880, p. 169 and 191), on the "genetic Connection of certain Unicellular *Phycochromaceæ*," of which abstracts were published in the "Royal Microscopical Journal."*

The conclusions arrived at are in favour of a sort of polymorphism.

"The lowest form of the Phycochromaceæ is the naked *Aphanocapsa* condition, corresponding to *Palmella* among the Chlorophyllophyceæ. From this naked or only slightly encysted condition is developed the *Glœocapsa* or *Glœocystis* form with several gelatinous envelopes; the *Chroococcus* type, when the investment is altogether wanting, or, when there is only a single vesicular envelope, the cænobium types. The *Glœocapsa* type is specially adapted for exposure to the air, and growth upon a comparatively dry substratum; the cænobium type is developed in water; the *Chroococcus* type in water, or on a moist substratum in the air. With this is connected the cylindrical form, a higher stage, because it displays a differentiation in the direction of growth, and a development towards the filiform condition. This is not always developed, and may be distinguished into stable and unstable forms; the latter may occur in two or three varieties, and may go through the following successive conditions:—

1.—Stable *Aphanocapsa* and *Palmella.*

2.—*Aphanocapsa* and *Palmella* which have attained to *Glœocapsa*, *Glœocystis*, or cænobium type, but which always revert to the naked solitary spherical form.

3.—Stable *Glœocapsa*, *Glœocystis*, *Chroococcus*, and cænobium forms, without reversion (*Merismopedia*).

4.—Cylindrical forms, the generations of which pass through the solitary spherical (*Aphanocapsa* and *Palmella*) condition, as well as the *Glœocapsa* and similar forms.

5.—Cylindrical forms, which pass through only the *Glœocapsa* and similar forms.

6.—Cylindrical forms the generations of which revert to the *Aphanocapsa* and *Palmella* condition, while the *Glœocapsa* or any similar form is suppressed.

7.—Stable cylindrical forms (*Synechococcus*).

No reference is made in the above to the passage of *Glœocapsa* into the encysted filiform conditions of *Sirosiphon* corresponding to *Palmodactylon* and *Hormospora* among the Chlorophyllophyceæ."

* Vol. I., Second Series, 1881, pp. 98 and 201.

FAMILY I. PALMELLACEÆ.

Unicellular algæ, in the broadest sense. Cells either solitary, or more or less numerous, associated in families, vegetating by cell-division, propagation by gonidia, which are produced from the ultimate generation of cells. Gonidia, when free, ciliate (usually with a pair of cilia) actively mobile.

GENUS 1. **EREMOSPHÆRA.** *De Bary.* (1858.)

Cells single, rather large, swimming free, spherical, cell wall firm, with a hyaline border. Cell contents (*Cytioplasma*) green, granulose, sometimes containing green lamina disposed in a radiate manner. Multiplication of the cytioplasm by division into two or four (or more) sister cells, which escape by the rupture of the cell-wall (*Cytioderm.*)

Eremosphæra viridis. *DeBy. Conj. p.* 56, *t.* viii. *f.* 26, 27.

Cells globose, large, of a beautiful grass green.—*Rabh. Alg.* iii. *p.* 24.

Chlorosphæra Oliveri, Henfr. Trans. Micr. Soc. vii. p. 25 (1859), pl. 3. Kirch. Alg. Schl. p. 115.

SIZE, ·0043-·0059 in. = ·11-·15 mm. (*Rabh.*), ·1-·12 mm. (*M.C.C.*).

In boggy ditches.

"The ordinary appearance of the plant is that of a large green globe, like a large spore, lying free in the water, or often gathered in loose groups upon decaying vegetable structures, such as leaves of *Sphagnum* contained in the water. The globe is a single simple cell, with a thin membranous coat surrounding a mass of usually green granular contents. Each cell produces two, or more rarely, four new ones."—*Henfrey.*

Plate I. Cells in various conditions, all magnified 400 diameters.

GENUS 2. **PLEUROCOCCUS.** *Meneg.* (1842.)

Cells segregated, globose (or angular from mutual pressure), with a central nucleus. Single or associated in small families which are either globose or cubical. Cell wall firm, often thick, even, hyaline. Cell contents homogenous green, or oily red. Multiplication of cells by division in alternate directions. Propagation by gonidia in proper cells (*Sporangia*).

Plants aquatic, or aërial.

**Species green.*

Pleurococcus vulgaris. *Meneg. Nost.* 38, *t.* 5, *f.* 1.

Cells variable in size, simple, binate or quaternate, or as many as 32 associated in families, aggregated in a crustaceous, powdery bright-green and somewhat gelatinous (when moist) stratum.

Size. Cells ·004-·007 mm.; fam. ·018 mm. (*Rabh.*), cells ·004-·006 mm. (C).

Rabh. Alg. iii. 24; Kirch. Alg. Schl. p. 115.

Protococcus valgaris, Kutz. Spec. p. 199.

Protococcus communis, Kutz. Tab. i., f. 3.

Pleurococcus communis, Desm. Exs. 1, 1203; ii. 603.

Hæmatococcus vulgaris, Hass. Alg. p. 333, t. 71, f. 5.

Chlorococcum vulgare, Grev. Sc. Cr., Fl. No. 262.

On the trunks of trees, moist walls, &c. Common everywhere throughout the year.

"Plant of a lively full green colour, spreading very extensively over the trunks of trees, and staining the fingers on the slightest touch. Granules very minute, exceedingly numerous, densely aggregated, and forming an uneven surface. They are perfectly free, semi-transparent, and adhere together in an opposite manner by fours."—*Greville.*

Plate II. fig. 1. *a*, natural size; *b*, cells × 400 diam.

Pleurococcus angulosus. (*Corda*) *Meneg. Nost. t.4, f. 5.*

Cells single, or 2-4, associated (64) in families, deep green, nestling in greenish, rather gelatinous stratum, cell-membrane thick, diaphanous.

Size. Cells ·007-·013 mm. (*Rabh.*).

Rabh. Alg. iii. 25. Kirch. Alg. Schl. p. 115.

Protococcus angulosus, Corda in Sturm Fl. ii. 18.

Microcystis angulosa, Kutz. Linnæa, viii. 374.

Protococcus palustris, Kutz. Tab. i., t. 4.

On the stems and leaves of aquatic plants.

In the Kew Herbarium copy of Rabenhorst's Algæ Exsicc, No. 327, under this name, only *Chroococcus turgidus* can be found, so that it is not quoted above.

Plate II. f. 2. Cells magnified 400 diam.

Pleurococcus (?) mucosus. *Rabh. Alg.* III. *p.* 26.

Cells very small, of variable size, single and 4-16, associated in globose families, scattered, or aggregated in a gelatinous green stratum. Cell-membrane very thin, hyaline, contents homogenous, decussately divided; nucleus rounded.

Size. Cells ·0023-·0003 mm. (*Rabh.*).

Protococcus mucosus, Kutz. Tab. i., t. 4.

Hæmatococcus theriacus, Hass. Alg. p. 333, t. 78, f. 9.

On the naked ground.

Dr. Allmann compares its appearance to inspissated syrup.

Plate II. fig. 3. Cells magnified 400 diam.

Pleurococcus Beigelii. *Küch & Rabh.*

Aërial, very small, very pale greenish, aggregated in numerous globose families, encircling the hair. Cell-membrane rather thick, colourless, contents very finely granular, sporangia containing 12-20 gonidia; nucleus globose.

SIZE. Cells ·006-·0095 mm. (*Rabh.*).

Rab. Alg. iii. 27.

"*The chignon fungus.*" Dr. Tilbury Fox, in "Science Gossip," May 1, 1867.

On human hair used as "chignons."

This organism, which is included by Rabenhorst amongst Algæ under the above name, is rather a doubtful production, at least it seems to be a doubtful alga. The late Dr. Tilbury Fox examined it carefully in 1867 with the following results:—

"If you take a hair on which the parasite exists, and hold it between yourself and the light, towards the outer half you will see one or more, perhaps half-a-dozen, little dark knots, the size of pin points, surrounding the shaft of the hair; they are readily felt on drawing the hair through the fingers; they are somewhat difficult to detach. Under the microscope, with a quarter-inch objective, the mass will be seen to be made up of cellular bodies surrounding the hair. It will be seen that the mass has the appearance of a fungus growth, of which two distinct forms are here present, viz., mycelial or filamentose, and sporular or cellular. The hair is apparently healthy, and if the slide be pressed the mass will break away from the hair on either side, bringing away with it more or less of the cuticle, and leaving behind a healthy shaft. The cells are seen to be of various shapes and sizes. They are from 1-4000 to 1-3000 of an inch, many are like the 'torula' cells developed from *Penicilium*. Others are larger, undergoing division very actively. They may be subdivided into two, three, or four parts, or much more freely. This indicates the assumption by the parasite of an algal condition. (It is this form to which the name *Pleurococcus Beigelii* manifestly applies.)

"In watching the mass on the hair carefully, it is evident that a number of small cells become detached from the outer or sporular form, and at once move actively about. These small cells indicate an active growth by subdivision, and a fruitful source of propagation. Certainly this variety of fungus, so far described, is the most active growth I have come across in my researches, and I have been enabled to germinate it most successfully, so as to set all questions as to its nature completely at rest. Placed under favourable circumstances in water, the spores enlarge considerably, and the mycelial filaments increase also, but there is at this time to be observed a very remarkable occurrence, though not in all cases. Some of the large cells have become filled with smaller cells, and in others, in addition to these, processes have been put forth from the circumference of the walls in a radiating manner; in other cases the enlarged cells have two long cilia attached to them, by which they move about rapidly, whilst a part of the hair previous to this free from the fungus, has become dotted all over by minute cells similar to those seen in the interior of the larger ones.

"But more than this, I have observed most distinctly large cells filled with smaller cells, furnished with exceedingly delicate radiating processes, and putting forth pseudopodia. It will here be seen to have assumed the features of an amæboid body. Nothing could have been more distinct to myself, and those who were observing with me, than this peculiar form; and it seems to me that we have here a pretty complete history of the life of the fungus—namely, the sporular subdividing and assuming an algal form, which in turn becomes amæbiform, and furnishes ciliated cells that supply the earliest condition of the fungus, scattered over the hair." Further details, with illustrations are given in the memoir, of which the above is an abstract, to which the student is referred.

Plate II. f. 4. Cells magnified 400 diam.

*** Species red or brownish.*

Pleurococcus miniatus. (*Kutz*) *Näg. Einz. Alg. p.* 65.

Cells very variable in size, globose, usually single, rarely 2-4 in a family, seated on a broadly effused red stratum, which is more or less gelatinous. Cell-membrane rather thick, colourless, hyaline, contents oleaginous orange.

Size. Cells ·0037-·016 mm. (*Rabh.*), ·0035-·015 mm. (*Kirch.*).

Rabh. Alg. iii. p. 27. Rabh. Exs. 31, 368, 1777. Kirch. Alg. Schl. p. 115.

On the walls of conservatories, all the year.

This is one of the species in which Braun has observed the "skinning off" of the outer cell-membrane.

Nägeli ascribes the red colour occurring in many *Palmellaceæ*, partly as a normal, partly as an abnormal phenomenon, to the formation of an orange-coloured oil in the place of the chlorophyll.* Braun says that probably all these have the power of retaining their life a long time in the dried condition; in the above species at least, he is quite sure of it. The brownish-red colour often acquired by *Protococcus viridis* may probably be explained in the same way.†

Plate II. fig. 5. Cells magnified 400 diam.

Pleurococcus roseo-persicinus. *Rabh. Alg.* III., 28.

Aquatic. Cells unequal, cloudy, single or binate, tegument hyaline, collected on a thin, rather gelatinous peach-rose coloured stratum.

Size. Cells ·0015-·004 mm.

Protococcus roseo-persicinus, Kutz. Tab. i. t. i.

Clathrocystis roseo-persicinus, Cohn, Beitr. iii. (1875), t. 6, f. 1-10.

Investing submerged aquatic plants.

This very minute species, with cells of a peach colour, is not uncommon about the *débris* of decaying plants in pools. The cells are usually agglomerated in spherical or elliptical masses. Certainly not a good *Pleurococcus.*

Plate II. fig. 6. Cells magnified 400 diam.

Genus 3. **GLÆOCYSTIS.** *Näg.* (1849.)

Cells globose or oblong, either single or 2-4-8, associated in globose families. Common and special integuments gelatinous, lamellose. Division in alternate directions. Propagation by zoogonidia.

The lamellose tegument distinguishes the species of this genus from *Pleurococcus.* Its analogue in the *Phycochromaceæ* is *Glæocapsa.*

** More or less green.*

Glæocystis ampla. *Kutz.*

Thallus gelatinous, rounded, lobed, dirty green. Cells globose, or rounded oblong, 2-4-6 (rarely 8), associated in families; tegument colourless, gelatinous, distinctly concentrically stratose. Contents green, granular.

* Einzelliger Algæ, p. 9. † "Rejuvenescence," p. 213, note.

SIZE. Cells ·009-·012 mm., fam. ·043-·09 mm. (*Rabh.*).
Rabh. Alg. iii. p. 29. Kirch. Alg. Schl. p. 112, partly.
Gleocapsa ampla, Kutz. Sp. p. 216. Tab. 3, f. 3.
Pleurococcus superbus, Cienk. Bot. Zeit., 20 Jan., 1865, p. 21. Archer Micr. Journ., 1866, p. 63.

Fixed to submerged plants.

Braun states that he has observed an irregular bursting and peeling off of the outer coat of multicellular families or sometimes of isolated cells surrounded by manifold coats in this species, and *G. vesiculosa.**

Plate III. fig. 1. Cells magnified 400 diam.

Glæocystis vesiculosa. *Näg. Einz. Alg. p.* 66, *t.* 4.

Thallus gelatinous, green; cells small, globose, as many as 64, and more, associated in families; tegument hyaline, colourless, lamellose, lamellæ often breaking up; contents green, delicately granular.

SIZE. Cells ·0045-·0075 mm.; fam. ·036 mm. (*Rabh.*).
Rabh. Alg. iii., 29. Rabh. Exs., No. 707.
Glæocystis ampla var. *vesiculosa*, Kirch. Alg. Schl. p. 112.

On wood and stones in stagnant water.

In character this species resembles the last, but the cells are smaller. See also Ciënkowski's paper in "Botanische Zeitung" for 20 January, 1865, where this species is figured to the same scale as *Glæocystis ampla.*

Plate III. fig. 2. Cells magnified 400 diam.

Glæocystis rupestris. (*Lyngb.*) *Rabh. Alg.* III., 30.

Thallus more or less expanded, dirty green, gelatinous, rather firm; cells globose, middle-size, associated in families; tegument colourless, pellucid, distinctly lamellose, soon diffluent; contents green, granular; sporangia globose, containing from 4-12 gonidia.

SIZE. Cells ·0037-·005 mm.; fam. ·06 mm.; sporang. ·085 mm. (*Rabh.*).
Rabh. Krypt. Fl. Sachs. p. 128. Rabh. Exs. 1790. Kirch. Alg. Schl. p. 112.
Palmella rupestris, Lyngb. Hyd. 207, t. 69. Hook. Eng. Fl. v. p. 397.

On rocks, moist walls, and damp earth.

"It occurs as a dirty yellowish gelatinous crust often hanging down in flakes from the face of the rock."—*Carm.*

This is *not*, or only in part, the *Hæmatococcus rupestris*, Hassall (p. 326, t. 82, fig. 1), which is chiefly applicable to *Glœocapsa polydermatica*, K.

Plate VIII. fig. 1. Cells magnified 400 diam. *a*, from wet rocks; *b*, from damp earth.

* See Braun, "Rejuvenescence," Ray Society, p. 182.

Glæocystis botryoides. *Ktz. Phy. Gen. p.* 173.

Thallus gelatinous, soft, sticky, green ; cells minute, globose and oblong, associated in small families; tegument colourless, indistinctly lamellose, contents green.

SIZE. Cells ·002-·004 mm.; families ·01-·018 mm.

Glœocapsa botryoides, Kutz. Tab. 1, t. 20.

On wood, submerged or constantly wet.

Plate III. fig. 3. Cells magnified 400 diam.

** *Flesh-coloured, becoming reddish.*

Glæocystis Paroliniana. (*Meneg. Nost. t.* 10, *f.* 2.)

Thallus crustaceous, cartilagineous (horny when dry), about a line thick, flesh colour; cells small, sphærical, 2-4-8 associated in families; tegument very broad, distinctly concentrically lamellose ; contents becoming yellowish, granulose.

SIZE. Cells ·0037-·005 mm.; families ·24 mm. (*Rabh.*).

Rabh. Alg. iii. 30.

Microcystis Paroliniana, Meneg. Nost. p. 78.

Glœocapsa Paroliniana, Kutz. Tab. i. 36, f. 5.

On rocks constantly wet.

Collected some years ago in Kent by Rev. M. J. Berkeley, and usually found near the sea.

Plate III. fig. 5. Cells magnified 400 diam.

Glæocystis adnata. (*Huds.*) *Näg.*

Thallus broadly expanded, gelatinous, firm, yellow-brown; cells globose, or oblong; contents brownish-green or brown, granular; tegument colourless, pellucid, lamellose.

SIZE. Cells ·008-·013 mm. (*Rabh.*).

Rabh. Alg. iii. 31.

Tremella adnata, Huds. Fl. Ang. p. 565.

Palmella adnata, Lyngb. Hydro. p. 205, t. 69. Berk. Glean. p. 40, t. 15, f. 2.

Microcystis adnata, Meneg. Nost. p. 85.

"Forming a thin yellow-brown, suborbicular, depressed stratum on chalk cliffs, about high-water mark. The individual plants, which are from 1-6 lines diam., are but very little thicker in the centre than at the margin. The surface is rugulose and shining, substance firm, between gelatinous and coriaceous. In age the plant gradually becomes more tawny, but at all times under the microscope presents a pale ochraceous jelly filled with darker granules. Under a moderate magnifier the granules appear globose, but under a lens with 1-25th in. focus pellucid, globose, colourless vesicles are seen to contain the darker granules, and these are found to be elliptic. Sometimes the vesicles contain a little tawny colouring matter, as though the sporules were broken down; and frequently the sporules burst through the coat of the vesicle in which they are contained, and lie free on the general mass."—*Berkeley.*

Plate III. fig. 4. *a*, natural size; *b*, cells magnified 400 diameters.

Genus 4. **UROCOCCUS.** *Hass.* (1845.)

Cells large, globose, or oblong, reddish or blood-red; tegument thick, gelatinous, concentrically lamellose; stem thick, gelatinous, often ringed or annulate.

All the species in this genus are rare, and with one exception confined to Britain. We are, therefore, compelled to reproduce figures already published, without measurements or information beyond the original descriptions.

The peculiar structure of the pedicellate cells is thus described by Braun:—"The large globular brownish-red or blood-red cells throw off colourless layers of cell membrane, which appear to be separated by intermediate layers of softer jelly, whence arises a distinctly concentric structure of the envelope. But the enveloping layers of *Urococcus* do not retain their original form and integrity; not increasing themselves in size, they are pushed off on the upper side by constantly succeeding inner coats, being at first merely attenuated at one side, but subsequently, as it seemed to me, actually broken through. Since this emergence from the old coats is always repeated on the same side, a membranous-gelatinous peduncle is produced formed of cups fitted one into another, so as to give an annularly streaked, apparently shortly articulated aspect. The red cell, which occupies the summit of this peduncle, sometimes divides, and this of course produces a subsequent dichotomy of the peduncle. If the periods of the formation of the separate enveloping layers were known, the age of the little plant, whose history is preserved in the gelatinous peduncle, might be determined by the number of rings."—*Rejuvenescence, p.* 179.

* *Stem annulate.*

Urococcus Hookerianus. *Hass. Alg. t.* 80, *f.* 4.

Cells globose, or elliptic, variable in size, blood-red, granular, stem more or less elongated, often divided, densely ringed.

Size. Cells ·013-·06 mm. (*Rabh.*).

Rabh. Alg. iii. 31.

Hæmatococcus Hookeriana, Berk. & Hass. in Hass. Alg. p. 325, t. 80, f. 4.

On chalk cliff, &c.

Plate IV. fig. 1. *a*, cells considerably magnified, after Hassall; *b*, cells further magnified, after Rabenhorst.

Urococcus insignis. *Hass. Alg. t.* 80, *f.* 6, *a. b.*

Cells large, globose, blood-red; stem abbreviated, remotely annulated.

Rabh. Alg. iii. p. 31.

Hæmatococcus insignis, Hass. Alg. p. 324.

"This very fine species I have never met with in any considerable quantity. Scattered isolated globules I have frequently met with, and these occasionally attached to a closely corrugated or ringed mucous appendage. Each globule is usually surrounded by a single vesicle or ring; in some globules, however, there are as many as four or five enclosing vesicles."—*Hassall.*

Plate IV. fig. 2. *a, b*, cells considerably magnified, after Hassall.

** *Stem without rings.*

Urococcus Allmanni. *Hass. t.* 80, *f.* 3.

Cells elliptical, blood-red; stem short, rather club-shaped, colourless, smooth.

Rabh. Alg. iii. p. 322.

Hæmatococcus Allmanni, Hass. Alg. p. 322.

In springs at Knaresborough.

Plate IV. fig. 3. *a,* cells considerably magnified, after Hassall; *b,* cells further magnified.

Urococcus cryptophilus. *Hass. t.* 80, *f.* 1.

Cells small, oval, rarely globose; tegument very large, confluent with the short ringless stem.

Rabh. Alg. iii. p. 32.

Hæmatococcus cryptophila, Hass. Alg. p. 324.

Hæmatococcus sanguineus, Harv. Man. p. 181.

Palmella cryptophila, Carm. in litt.

On stalactites lining a cavern in a quartz rock.

"Forms wide patches externally of a brick-red colour, but within whitish, breaking up easily into the numerous separate portions of which each mass is formed. The colour resides alone in the granules; these terminate the superior extremity of the mucous prolongations, which are colourless, and arranged almost entirely side by side. The granules or cells are several times smaller than in *U. Allmanni.*"—*Hassall.*

Plate IV. fig. 4. *a,* cells considerably magnified, after Hassall; *b,* cells further magnified.

GENUS 5. **SCHIZOCHLAMYS.** *Br.* (1849.)

Cells globose (or ovate), either single, or 2-4 associated in families; tegument lamellose, as age advances dividing regularly in 2-4 equal parts, some time adhering by means of a hyaline colourless mucous. Division in one or two directions. Zoogonidia produced by a repeated division of the cell contents.

At present represented in Europe by a single species.

"The globular cells of this little Alga produce a hyaline cell-membrane, which becomes removed to some distance from the green body of the cell by subsequent secretion of fluidish jelly; soon, however (probably from endosmose), becoming unable to withstand the expansion of the jelly, it splits in the direction of an equatorial circle, by a clean line, into two similar halves, or if the dehiscence takes place by two circular lines, cutting at right angles, into four similar pieces. This splitting and peeling of the membrane either coincides with a division of the internal cell-mass, or it occurs without any such division. By frequent repetition of this process the cell gradually becomes surrounded by an accumulation of old fragments of the membranous shell, which are held together by the extremely transparent jelly set free. The division of the cell may be either a simple halving, in which case each part is immediately clothed again with a hyaline cell-membrane, or double, through the cells produced by the first division separating immediately into two cells, without previously acquiring a coat of cell-membrane, and therefore without skinning."—*Braun Rejuvenescence, p.* 181.

Schizochlamys gelatinosa. *Br. in Kutz. Sp. p.* 891.

Cells globose ; contents green, granulose.

SIZE. ·01-·0135 mm. (*Rabh.*).

Kutz. Tab. vol. vi. t. 70. Braun Rejuvenescence t. 2, f. 43-50. Rabh. Alg. iii. 32. Rabh. Exs. No. 103.

In peaty swamps, moor pools, and boggy ditches.

Plate III. fig. 6. Cells magnified 400 diam.

GENUS 6. **PALMELLA.** *Lyngb.* (1819.)

Cells globose, oval, or oblong, surrounded with a more or less thick integument, generally very soon confluent into a firm or soft jelly. Thallus shapeless. Division of the cells alternately in all directions.

* *Mostly green.*

Palmella mucosa. *Kutz. Phyc. Gen. p.* 172.

Thallus expanded, gelatinous, deformed, olivaceous-green ; cells large, nearly equal, pale green, delicately granular ; tegument very thin, soon diffluent.

SIZE. Cells ·015 mm. (*Rabh.*), ·007-·014 mm. (*Kirch.*).

Rabh. Alg. iii. 33. Kirch. Alg. Schl. p. 110.

Merettia mucosa, Trevis. Alg. p. 46.

On stones in streams.

Plate V. fig. 1. Portion of thallus with cells magnified 400 diam.

Palmella hyalina. *Breb. Alg. Fal. p.* 39.

Thallus gelatinous, irregularly expanded, green ; cells very minute, crowded ; tegument almost homogenous with the gelatinous thallus, very soon diffluent.

SIZE. Cells ·0005-·001 mm. (*Rabh.*), ·00075-·001 mm. (*Kirch.*).

Rabh. Alg. iii. 33. Rabh. Exs. 1525. Kirch. Alg. Schl. p. 110.

Coccochloris hyalina, Meneg. Nost. p. 66.

In stagnant water, and bogs.

The species called *Coccochloris hyalina* by Hassall (p. 315) is *Homalococcus Hassallii*, Kutz., one of the *Phycochromophyceæ*, and not the present. Perhaps the two may have been mixed up.

Plate V. fig. 3. *a*, part of thallus, × 400 ; *b*, portion × 800 diam.

Palmella Mooreana. *Harv. Man. p.* 178.

Thallus irregularly globose, tuberculate, dark green, gelatinous, firm. Cells nearly equal, pale green.

SIZE. Cells ·008 × ·005 mm.

Rabh. Alg. iii. p. 34.

Coccochloris Mooreana, Hass. Alg. 316, t. 78, f. 1.

In bogs and stagnant water.

"The fronds are of an irregular globose form, about an inch in diameter, tuberculated, and inclining to become hollow in the centre when old, at which time it floats on the surface; the colour is dark-green and the substance firm, resembling that of an animal's liver."—*Moore.*

We found this species floating freely in a pond in Sutton Park, Birmingham. In this condition it has just the appearance and texture of a *Nostoc.* Is it distinct from *Aphanothece prasina ?*

Plate V. fig, 4. *a,* plant natural size; *b,* portion × 400 diam.

***Reddish or orange.*

Palmella miniata, var. **æqualis.** *Näg. Einz. Alg. t.* 4, D. 2.

Thallus expanded, soft, amorphous, brick-red; cells nearly equal, tegument somewhat thick, colourless, hyaline, indistinctly striate; contents orange, sometimes greenish.

SIZE. Cells ·012-·014 mm.

Rabh. Alg. iii. 34. Rabh. Exs. No. 1778.

Sorospora grumosa, Hass. Alg. p. 310, t. 80, f. 7. ?

On wet rocks, moist ground, &c.

We are of opinion that this is the *Sorospora grumosa* of Hassall. The typical form of *Palmella miniata* has very minute cells, not exceeding ·0035-·004 mm., but this variety, if it be not a distinct species, has cells nearly four times as large.

Plate V. fig. 2. Portion of thallus, magnified 400 diam.

Palmella prodigiosa. *Mont. Comptes Rend.* 1852, 119.

Thallus more or less expanded, blood-red, as age advances moist, or sometimes dripping; cells very minute, globose, crowded.

SIZE. Cells ·00075-·001 mm. (*Rabh.*).

Rabh. Alg. iii. 34. Stephens, Ann. Nat. Hist. 2 Ser. (1853), xii. 409. Berk. in Gard. Chron. 1853, p. 515.

Monas prodigiosa, Ehrb. Monat. Berl. 1848.

Zoogalactina imetropha, Sette. Mem. Ven. 1824.

On rice, bread, potatoes, &c.

In the time of Ehrenberg this was considered a minute animal, and was included amongst Monads. The blood-red spots which it forms on bread, rice, potatoes, and other mealy substances, caused great alarm in more superstitious times. Until very recently opinions were by no means settled on this subject. The Rev. M. J. Berkeley held it to be a condition of fungoid life, and in his "Introduction"* he says, "*Palmella prodigiosa,* from its peculiar habit, seems rather to indicate affinity with fungi. The rapidity with which it spreads over meat,

* "Introduction to Cryptogamic Botany," p. 114.

boiled vegetables, or even decaying Agarics, is quite astonishing, making them appear as if spotted with arterial blood; and what increases the illusion is, that there are little detached specks, exactly as if they had been squirted in jets from a small artery. The particles of which the substance is composed have an active molecular motion, but the morphosis of the production has not yet been properly observed, and till that is the case it will be impossible to assign its place rightly in the vegetable world. Its resemblance to the gelatinous specks which occur on mouldy paste, or raw meat in an incipient state of decomposition, satisfy me that it is not properly an Alga." Mr. H. O. Stephens, on the other hand, contends that it is an Algoid production. After narrating its history (see "Ann. Nat. Hist.," 1853, p. 409), he says—"I observed at table the under surface of a half-round of boiled salt beef, cooked the day before, to be specked with several bright carmine-coloured spots, as if the dish in which the meat was placed had contained minute portions of red currant jelly. On examination the next day, the spots had spread into patches of a vivid carmine-red stratum of two or more inches in length.

"With a simple lens the plant appears to consist of a gelatinous substratum of a paler red, bearing an upper layer of a vivid red hue, having an uneven or papillate surface. The microscope shows this stratum to consist of generally globose cells immersed in or connected by mucilaginous or gelatinous matter. The cells vary in size, and contain red endochrome. As far as I can observe they consist of a single cell-membrane, and contain a nucleus. Treated with sulpho-iodine, they become blue. In my judgment this plant is a *Palmella* closely allied to *P. cruenta*, but certainly distinct, the cells or granules of the latter differing from it not only in their colour but size." The memoir also contains observations on the great vitality of this species, and other subjects connected therewith, to which the student is referred.

Plate V. fig. 5. *a*, part of thallus, magnified 400 diam.; *b*, portion magnified 800 diam.

GENUS 7. **PORPHYRIDIUM.** *Näg.* (1849.)

Thallus between gelatinous and membranaceous, somewhat incrusting, long and broadly expanded, composed of globose or many-sided cells. Multiplication of the cells by alternate division in all directions. Propagation unknown.

This genus is placed by some authors in *Porphyraceæ*, near the genus *Bangia*, in the class *Rhodophyceæ* (see Rabh. Alg. iii. 397), but we prefer to retain it near the old genus *Palmella*, in which it was previously included, and to which it seems to be most naturally allied.

Porphyridium cruentum. *Näg. Einz. Alg. t.* 4 H.

Thallus dark purplish-red, gelatinous; cells angular or rounded.

SIZE. ·007-·01 mm. (*Rabh.*), ·0065-·009 mm. (*Kirch.*).

Kirch. Alg. Schl. p. 111. Rabh. Alg. iii. 397.

Palmella cruenta, Ag. Syst. p. 15. Rabh. Exs. No. 14 and 1071. Hass. Alg. p. 308, t. 80, f. 5.

Tremella cruenta, Eng. Bot. t. 1800. Grev. Sc. Crypt. Fl. pl. 205.

On the naked ground, moist walls, &c. Common throughout Europe.

The red spots are at first rounded, then irregular, soon confluent, and form an expanded crust, like coagulated blood of a deep purple colour.

Plate V. fig. 6. *a*, plant natural size; *b*, cells magnified 400 diam.

GENUS 8. **BOTRYDINA.** *Breb.* (1839.)

Cells oblong or rounded, involved in a very thick, gelatinous, partially diffluent integument, in large families, which are often very numerous, enclosed in a mother cell which constitutes a subglobose thallus.

Only one species in this genus.

Botrydina vulgaris. *Breb. in Hass. Alg.* 320.

Thallus minute, rarely larger than the head of a pin, globose, green.

SIZE. Thallus from 1-500th to 1-10th mm.; cells ·002-·004 mm.

Meneg. Nost. p. 98, t. 13, f. 2. Rabh. Alg. iii. 37. Rabh. Exs. No. 388. Hass. Alg. p. 320, t. 81, f. 2. Kirch. Alg. Schl. p. 111.

On moist ground, trunks, moss, &c.

"The fronds of various sizes, rarely surpassing the head of a pin, of a subsphærical form, aggregated in considerable quantity, cover the stems of mosses with a pulverulent blackish-green stratum, which Agardh first well delineated. The granules, in the beginning solitary, here and there affixed, subsphærical, or slightly angular, scarcely equal in their greatest diameter 1-500th mm.; gradually they increase in size, and when they have arrived at the 1-200th mm. they manifest an internal granular substance; at a later period having acquired a form exactly spherical, the internal substance is seen aggregated or collected into the centre, and the granules surrounded by a pellucid margin. Again, they increase in size, and the interior granules are seen converted into vesicles filled with lesser granules. These vesicles increased in number and magnitude, the greatest dimensions of the frond being attained, occupy its entire substance, and at length the diaphanous margin disappears. The whole frond is then constituted of vesicles closely heaped together, and enclosing granules in the centre. The primitive membrane, enclosing in its midst the interwoven or cellular structure, is so closely united with the peripheral stratum of vesicles, that it can in no way be separated from it. The last development having been accomplished, the peripheral stratum of vesicles altogether loosens its granules; whether these disappear by absorption or escape outwardly, I have never been able to perceive. In this manner the frond again obtains a diaphanous margin, but different from that with which, in the beginning, it was surrounded."—*Meneghini.*

Plate XI. fig. 3. *a*, thallus magnified 400; *b*, cells further magnified.

GENUS 9. **PALMODICTYON.** *Ktz.* (1845.)

Cells oval or globose, with a very thick gelatinous integument, united into a filiform thallus, which is connate or anastomoses in various ways. Cell division simple or double (decussate). Propagation by zoogonidia from the ultimate generation of cells.

Palmodictyon viride. *Kutz. Tab. Phy.* I. *t.* 31, *f.* 1.

Thallus mucous, irregularly reticulate, about the thickness of a hair, greenish ; cells biserial, with a very thick homogenous tegument.

SIZE. Cells without tegument, ·0075-·009 mm., with the tegument ·025-·04 mm. (*Rabh.*).

Rabh. Alg. iii. 37. Kutz. Phy. Germ. p. 155.

In ditches, canals, &c., attached to stones, twigs, &c.

Recently found by Mr. E. Parfitt near Exeter, of which he gives the following account :—" The plant, where it has sufficient room to develope itself, spreads over the bottom, in water about six inches deep ; beyond this it comes in contact with *Elodes canadensis*, over which it creeps, and extends its growth from branch to branch into deeper water. In this extension it has first the appearance of a *Conferva*, which I at first took it to be ; but the moment I touched it, after taking some from the water, I found from the soft slimy feel that if a *Conferva* it was new to me, and the microscope soon revealed the true character. When the plant grows on the bottom it shows one continuous green membrane, stretched tight over the bottom, but when it comes in contact with other plants it throws out filaments, the thickness of which is difficult to make out on account of their adhesive nature ; for wherever they touch it is matter of impossibility to separate them. The membrane forming the filaments is structureless, but the sphærical cells, which form more or less moniliform threads, sometimes running in parallel lines, at other times forming an irregular net-work on the inside of the filaments. These cells sometimes divide into two portions, at others into four, and in most of the mature cells may be observed four cellules."—*Grevillea*, iii., *p.* 29.

Plate VIII. fig. 2. *a*, portion magnified 200 diam. ; *b*, fragment magnified 400 diam.

Palmodictyon rufescens. *Kutz Spec.* 234.

Is usually referred here on the faith of the remark by Kutzing, that it was found at Aberdeen by Dr. Dickie. Upon enquiry of Dr. Dickie we learn that he knows nothing of the species. He says, "*Palmodictyon rufescens* is unknown to me, many years have passed since I corresponded with Lenormand, and I do not remember receiving any note from him regarding it. Kutzing (Spec. 234) is responsible for the name. I cannot find in my collection anything so named, neither do I remember where the so-called material was collected." Under these circumstances it is useless repeating the name in connection with British Algæ.

GENUS 10. **TETRASPORA.** *Link.* (1810)

Thallus gelatinous, membranous, or submembranous, in the beginning a short sac, afterward expanded ; cells globose or angular, more or less distant, but associated in a single stratum into large families. Tegument thick, very rapidly diffluent into a homogenous mucous. Division in two directions in the same plane.

Tetraspora bullosa. *Ag. Sp. Alg. p.* 414.

Thallus membranaceous, saccate, obovate, sinuate, bullose, an inch to a palm long, dark green, more or less verrucose; cells nearly sphærical (after division hemisphærical or angular), geminate, or quaternate, crowded, granular.

SIZE. Cells before division ·008-·012 mm., after division ·0058-·0075 mm. (*Rabh.*).

Rabh. Alg. iii. 39. Rabh. Exs. No. 115, 1233. Kirch. Alg. Schl. p. 108.

Monotrema bullosum, Thur. Mem. Cherb. 1854.

Tetraspora minima, Desv. Flor. Aug. p. 17.

Ulva bullosa, Roth. Cat. iii. 320. Hook. Brit. Fl. ii. 312. Harv. Man. p. 171. Hass. Alg. t. 78, f. 13. Dickie Bot. Guide, p. 306. Eng. Bot. ed. 2, t. 2405.

Stagnant pools and ditches of fresh water.

Plate VI. fig. 1. *a*, natural size; *b*, fragment mag. 400 diam.

Tetraspora gelatinosa. (*Vauch.*)

Thallus vesiculose, ovate-clavate, or obovate, gelatinous, with age unequally expanded, irregularly torn, pallid and sometimes dirty-green, often incrusted with lime; cells of variable size, globose, either single or geminate, and scattered or quaternate, or geminate, and somewhat crowded; contents green and granular.

SIZE. Cells ·003-·014 mm. (*Rabh.*).

Rabh. Alg. iii. 40. Hook. Br. Flor. ii. 313. Mackay Flor. Hiber. p. 244. Hass. Alg. p. 301. Kirch. Alg. Schl. p. 109.

Ulva gelatinosa, Vauch. Hist. p. 244, t. 17, f. 2.

Rivularia tubulosa, DC. Fl. Fr. ii. p. 5.

In pools and ditches.

Plate VI. fig. 2. *a*, natural size; *b*, fragment mag. 400 diam.

Tetraspora lubrica. (*Roth.*)

Thallus elongated, tubular, erect, an inch to a palm long, 1-4 lines thick, splitting, undulate, sinuous, sticky, between gelatinous and membranaceous, yellow-green; cells globose, or rather angular, of medium size, green; tegument very thin.

SIZE. Cells ·008-·01 mm. (*Rabh.*).

Rabh. Alg. iii. 41. Rabh. Exs. No. 51. Dickie Bot. Guide, p. 306. Eng. Bot. ed. 2, t. 2407. Hass. Alg. p. 300, t. 78, f. 10. Kirch. Alg. Schl. p. 109.

Tetrasporella lubrica, Gaill. Desm. Ex. i. 655.

Ulva lubrica, Roth. Cat. i. 204.

Conferva lubrica, Roth. Cat. iii. 168.

Plate VI. fig. 3. *a*, natural size; *b*, fragment mag. 400 diam.

Tetraspora flava. *Hass. Alg. t.* 78, *f.* 11.

Thallus yellow when dry, cellules small, quaternate.

Rabh. Alg. iii. p. 42.

In rocky rivulets.

"This species, at all events, would appear to be distinct, the cells being two to three times smaller than those of *T. lubrica* and *T. gelatinosa.*"—*Hassall.*

This is a doubtful species, which no one but Hassall appears to have seen.

Plate VI. fig. 4. Fragment magnified, after Hassall.

GENUS 11. **BOTRYOCOCCUS.** *Kutz.* (1849.)

Thallus botryoid (or like a bunch of grapes), irregularly lobed, mucous, involved in a thin parent membrane (?). Cells ovoid or elliptic, united in families, which are densely packed within a thin diffluent tegument.

Represented in Europe by a single species.

Botryococcus Braunii. *Kutz. sp.* 892.

Small, free swimming, green, at length becoming pallid or reddish-brown.

SIZE. Cells ·01-·0125 mm. (*Rabh.*).

Rabh. Alg. iii. 43. Fres. in Abh. Senk. t. ii. f. 27-33. Archer Micr. Journ., 1870, p. 88. Kirch. Alg. Schl. p. 111.

In moor pools.

Specimens were found by Dr. Moore floating on the surface of Lough Bray in long sheets of some yards in length. Mr. Archer remarked upon these "that this was not an uncommon alga in moor pools, sometimes coating submerged sedges, and the like, with a greyish green stratum, sometimes, however, suspended in the water in streaks, and often isolated. It passes through a red condition. More than once, when a single group or family of this alga, from gatherings kept for some time in the house, had turned up under a low power of the microscope, he had been to some extent deceived by the way in which it resembles some radiolarian rhizopod, strange as it may seem. The mucous matrix containing the families of cells seems not unfrequently to give off rather long, filiform prolongations, which stand out more or less radiantly, looking not unlike pseudopodia and these are undoubted rhizopoda containing chlorophyll. It might, indeed, be a good example of two objects with no affinity in any respect to each other, still superficially simulating one another."—*Micro. Journ.*, 1870, *p.* 88.

Plate VII. fig. 2. *a*, family group; *b*, single family; *c*, undergoing segmentation; *d*, free mature cells. All magnified 400 diameters.

GENUS 12. **APIOCYSTIS.** *Näg.* (1849.)

Thallus small, vesicular, fixed by a stem-like base. Cells globose, scattered, or sometimes 8 disposed in a circle; contents homogenous, or delicately granulose, with a distinct colourless vacuole; tegument thick, dissolving into a homogenous gelatine, cells dividing alternately in all directions. Propagation by mobile gonidia, which are globose, and furnished with a pair of vibratile cilia.

This genus consists of a single species, unless the variety *linearis* of Nägeli is entitled to rank as specifically distinct.

Apiocystis Brauniana. *Näg. Einz. Alg. p.* 69.

Thallus pear-shaped, pallid green, the cavity filled up by gelatinous matter, in which are imbedded the gonidia, at first few, increasing in number with age, as far as 1600.

SIZE. Frond ·04-·1 mm. high, gonidia ·012 mm. diam., cells ·0075-·011 mm. (*Rabh.*).

Rabh. Alg. iii. 43. Fresen. Beitr. p. 237, t. ii. f. 1-20. Henfrey in Micro. Journ., 1856, p. 52, t. 4, f. 26-27.

Fresh water ditches, &c.

Professor Henfrey found this plant in January, in a jar of water containing aquatic plants brought from Wimbledon Common six months previously. The development, as recorded by Nägeli, is detailed in the article quoted above.

"The young 'swarm cells' (zoospores) attach themselves by their ciliated point (especially to *Cladophora fracta*), and become invested with a club-shaped, enveloping membrane. The first division of the green body then takes place in the direction of the axis of the vesicular envelope, and is repeated alternately in each direction of space. During this the vesicle in which the cells (gonidia) lie, continually expands, and generally becomes very evidently pedunculated. Young vesicles contain a regular number of cells, namely, 2, 4, 8, 16, 32, &c., but the number afterwards becomes indefinite; in largish vesicles, 1-50″ (·5 mm.) long and 1-120″ (·22 mm.) diam. I have counted about 300; in the largest, about 1-25″ (·1 mm.) long and 1-50″ (·5 mm.) thick, some 1,600 cells.

"The cells (gonidia) are at first uniformly distributed over the whole cavity of the vesicle. Subsequently they generally become collected on the internal surface of the wall of the vesicle, where they lie in one or more strata. But the cell division always takes place in all directions of space, the cells situated internally advancing outwards towards the periphery. In old vesicles the cells are sometimes arranged in rings of eight upon the wall. When the family of cells is mature for 'swarming,' which may occur at very different sizes and with very different numbers of gonidia, the cells begin to move, at first slowly, from their places, and then gradually to circulate more rapidly in and out about each other; the vesicle bursts, and the gonidia emerge by the orifice which is formed. Sometimes the swarming is preceded by the state in which the cells are arranged in parietal rings.

"The cells secrete an abundant gelatinous coating, which becomes softened within the vesicle, and confluent into a structureless jelly. The vesicle sometimes appears merely as the boundary line of the jelly; in general, however, it may be distinguished as a distinct wall composed of denser gelatinous substance, the internal outline of which is always distinct and sharp, while the outer is frequently indistinct, and partly dissolved."—*Nägeli.*

Plate VII. fig. 1. *a*, young frond; *b* and *c*, older fronds × 100 diam.; *d*, frond with cells undergoing segmentation × 200; *e*, part of frond with mature gonidia × 400; *f*, free gonidia; *g*, ciliated gonidia or zoospores × 400 diam.

Inoderma lamellosum, Kutz., has been said to have occurred in Britain, but we have not been able to satisfy ourselves of its occurrence.

GENUS 13. **RHAPHIDIUM.** *Kutz.* (1845.)

Cells fusiform, or cylindrical, generally very gradually cuspidate or acuminate at the ends, rarely obtuse, straight or variously curved, single, geminate, or fasciculately aggregate, decussate in the centre, or radiately conjoined, rarely two laterally united at the end, other cells free. Tegument thin, smooth. Contents green, very finely granular, furnished with a central, or rarely lateral, transparent vacuole. Division of the cells only in one direction.

Rhaphidium aciculare. *Braun. Rabh. Exs.* 442.

Very slender, 15-20 times as long as broad, yellow-green, often single, acicular, acutely cuspidate at each end, straight, or slightly curved or somewhat lunate.

Ankistrodesmus acutissimus, Archer in Micr. Journ., 1862, t. xii. f. 44-56.

Closterium Griffithii, Berk. Ann. Nat. Hist. xiii. 256, t. 14, f. 2.

Rhaphidium polymorphum var. *γ aciculare,* Rabh. Alg. iii. 45.

In pools.

"Cells very minute, 20-25 times longer than broad, fusiform, very slender, straight, very acutely acicular, solitary or forming fasciculi of 2-4 cells; endochrome light-green, mostly with a minute parietal semicircular or rounded pale body or space placed near the middle of the cell, otherwise usually appearing homogenous, sometimes slightly granular." It agrees with *R. falcatum* in its very slender and acute cells, but it differs from it by its straight, not arcuate cells, by its fusiform more quickly attenuated cells, by its more intensely acute extremities, and by the constituent cells of an old fasciculus being much fewer in number.—*Archer.*

Plate VIII. fig. 3. Cells magnified 400 diam.

Rhaphidium falcatum. *(Corda.)*

Fusiform, slender, acutely cuspidate at each extremity, curved, or semi-lunar, 4-16 congregated in fascicles.

Micrasterias falcata, Corda Alm. Carls. 1835, p. 121, t. 2, f. 29.

Staurastrum falcatum, Ehr. Weigm. Arch. 1836, p. 185.

Closterium falcatum, Meneg. Linnæa, 1840, p. 233.

Ankistrodesmus gregarius, Breb. in litt.

Ankistrodesmus falcatus, Ralfs Desm. t. 34, f. 3.

Rhaphidium polymorphum, var. c. *falcatum,* Rabh. Alg. iii, 45.

In pools.

It is a very common plant in ponds, &c., and resembles a minute young *Closterium,* except that although some individuals may be solitary, others will be seen in the same gathering collected in the characteristic fascicles.

Plate VIII. fig. 4. *a,* families magnified 400; *b,* magnified 800 diam.

Rhaphidium duplex. *Kutz. Phyc. Germ. p.* 144.

Fusiform, slender, slightly sigmoid, single, or 2, 3, or 4 laterally connected at the poles, otherwise free.

Rhaphidium triplex, Rabh. Krypt. Fl. Sax., p. 134.

Scenedesmus duplex, Ralfs Desm. 193, t. 34, f. 17.

Rhaphidium polymorphum var. d. *sigmoideum*, Rabh. Alg. iii. p. 45.

In pools (apparently rare).

"Cells linear-lanceolate; extremities tapering to a fine point and curved in opposite directions. The cells closely united, frequently the frond, consists of only a single pair of cells so connected, but sometimes of two or even three of these pairs, which, however, are remote from each other, in this case; as the connecting mucous is colourless, they look like distinct plants, and their relation can be detected only by moving the frond. If kept in water for a few days, the cells separate from each other."—*Ralfs.*

This description is scarcely accurate, as each cell is a distinct plant.

Plate VIII. fig. 5. *a*, cells magnified 400; *b*, magnified 800 diam.

Genus 14. DICTYOSPHÆRIUM. *Näg.* (1849.)

Cells elliptic, with thick confluent mucous investment, combined in numbers into free-swimming one-layered hollow-globular families, one always at the ends of delicate threads which proceed from the central point of the family, and which become repeatedly branched towards the periphery; division at the commencement of a series of generations in all directions of space; afterwards, as regards the middle point of the aggregate family, as a rule, alternating only in the two tangental directions.

Only three described species, all of which have occurred in the British Isles.

Dictyosphærium Ehrenbergianum. *Näg. Einz. Alg. p.* 73.

Families aggregated in a globular, or broadly elliptical figure; cells elliptic, very minute, about one-third as broad as long.

Size. Cells ·004-·0075 mm. (*Rabh.*), ·004-·007 mm (*Kirch.*).
Rabh. Alg. iii. 47. Kirch. Alg. Schl. p. 106.

Amongst *Confervæ.*

"This form is very minute, and in suitable places, common, the families in the aggregate forming a globular, or broadly elliptic, or sometimes subcubical figure; the rate of growth of the delicate thread being equal all round, the cells at the ends of each of its dichotomous ramifications stand at nearly equal distance from the original centre; hence the regular figure of the aggregate family. The individual cells are elliptic, and very minute."—*Archer.*

Plate IX. fig. 1. Families magnified 400 diam.; *b*, fragment with cells × 400 diam.; *c*, variety with spherical cells.

Dictyosphærium reniforme. *Buln. Hedwigia* II. 22.

Families aggregated in an irregular form; cells reniform, nearly twice as broad as long.

SIZE. Cells ·008-·009 mm. (*Rabh.*), ·006-·01 × ·01-·02 mm. (*Kirch.*).

Rabh. Alg. iii. 47. Rabh. Exs. 789. Archer in Micro. Journ., 1868, viii. p. 65. Kirch. Alg. Schl. p. 106.

In pools. Near Snowdon, N. Wales.

"This plant possesses larger families than *D. Ehrenbergianum*, which are irregularly shaped, seemingly owing to the development of the delicate supporting fibre not going on in the same regular manner as in the preceding species, and the cells themselves are much larger and reniform."—*Archer.*

Plate IX. fig. 2. *a, b,* plants magnified 400 diam.; *c,* portions showing filament.

Dictyosphærium constrictum, *Archer* (*Micr. Journ.*, 1866, *p.* 128) having been afterwards found to produce zygospores (see "Micro. Journ.," 1875, p. 415), has been transferred to the *Desmideæ* in company with *Cosmocladium*, to which genus it seems to be ...

...ladium Saxonicum, *DeBary*, is sometimes placed by ... (as in Rabenhorst's Algæ) in this family. But, as ... demonstrated in "Flora" (No. 21, 1865), the cells ...ed in the same manner as in *Cosmarium*, and therefore its ...er place is with the *Conjugatæ*, as one of the *Desmideæ*. ... has been found in North Wales.

GENUS 15. **HORMOSPORA.** *Breb.* (1840.)

Thallus tubular, gelatinous, swimming free. Cells oblong, or oval, green, arranged in simple longitudinal series (families), either remote from each other, or more or less united at the poles. Tegument thick, confluent, contained within the broad gelatinous tube, which is either simple or branched.

* *Tubes simple.*

Hormospora mutabilis. *Breb. Mem. Fal.* 1840.

Tubes intricate, more or less broad, or parallel and coalescing; cells twice as long as broad, broadly rounded at each end; tegument very thin.

SIZE. Cells ·011-·017 mm., tube diam. ·043 mm. (*Rabh.*).

Rabh. Alg. iii. 48. Breb. in Ann. des Sci. Nat., 1844, t. i. f. 2. Kirch. Alg. Schl. p. 108.

In boggy pools. Ireland.

Plate X. fig. 1. *a,* portion of filament × 300; *b,* same breaking up × 300.

Hormospora transversalis. *Breb.*

Tubes slimy, equal or undulate; cells ovate-oblong or fusiform, disposed transversely in a moniliform series; contents granular.

SIZE. Diameter of tube ·075-·12 mm.

Rabh. Alg. iii. 49.

In bogs.

Plate X. fig. 3. *a*, portion of filament × 200 diam.; *b*, portion × 400 diam.

** *Tubes branched.*

Hormospora ramosa. *Thwaites.*

Tubes broad, gelatinous, irregularly branched; cells oval or nearly cylindrical, obtuse at the ends, either remote from each other or connected, twice as long as broad; contents green, with green laminæ radiating from the centre.

Thwaites in Harvey Phy. Britt. t. 213. Rabh. Alg. iii. 49.

In brackish and salt water, attached to *Cladophora.*

The filaments in this species, unlike those of the preceding two species, are branched.

Plate X. fig. 2. *a*, portion of filament × 200; *b*, small portion with cells × 400.

GENUS 16. **CYLINDROCAPSA.** *Reinsch.* (1867.)

Cells sphærical or ellipsoid, membrane thick, either with a three or fourfold tegument, or naked; cells associated in a linear series in families, enclosed in a cylindrical hyaline gelatinous tube; cells dividing transversely. Propagation by gonidia uncertain. Cell contents green, granular, with a single chlorophyllose corpuscle.—*Reinsch Algenflora, p.* 66.

Cylindrocapsa involuta. *Reinsch Algenflora, tab.* VI. *f.* 1.

Cells ellipsoid, ultimately involved in a fourfold tegument, which is expanded at the poles.

SIZE. Cells ·023-·03 mm. diam.

This plant has occurred in Ireland, as recorded by Mr. W. Archer, in "Grevillea" (Vol. III. p. 40), with the following observations:—

"Admitting the identity, of which I myself do not doubt, though not previously having seen examples, that author's description of this minute alga does not appear quite complete, as he omits to mention that the cylindrical hyaline envelope of the cells, combining them into a frond, is closed at both extremities, rounded off at the upper, and somewhat produced, tapered and thin, slightly dilated into a scutate organ of attachment (to foreign objects) at the lower extremity. Thus the extremities appear to be differentiated into a basal and apical. The Irish plant agreed with Reinsch's in the dimensions of the cells, their oval figure (truncate after division, whilst closely apposed, and until full size is again attained), their longer diameter posed in the direction of the length of the cylindrical filament and in their being involved by a number of concentric hyaline investments standing off from the cells at the poles, closely applied at the sides; not, however (as Reinsch shows) uniformly *four*, but two, three, or four, and standing off from the cells, not equidistantly, but at different distances. It is, however, quite possible that where the fewer number only of laminæ of the envelopes were apparent, others may have been present, but so closely applied to the cells (and to each other) as to appear as if absent. Just as depicted by Reinsch (though his figure be rather stiff), I saw some of the cells undergoing self-division, the fission always taking place through the shorter diameter, the new cells, at first flattened at the ends, then growing as long as the older, and becoming rounded off, and thus the longitudinal direction of the cells is maintained. Thus this form is unlike *Cylindrocapsa nuda* (Reinsch), in which the oval cells are placed transversely, and appear to be without the loose outer envelopes. The author does not state that the contents are not a bright, but a dull lurid green, very opaque. On endeavouring to preserve this plant, it 'kept' not at all, colour became lost, envelope shrivelled, and even after a couple of days the examples did not represent the same thing as when fresh.

"Thus the morphology of the plant points to an affinity with *Hormospora*, Breb., which, too, has its forms with the elliptic cells placed longitudinally (*H. mutabilis* and others) and transversely (*H. transversalis*), but no *Hormospora*, except *H. ramosa*, Thwaites, appears attached; the contents, too, are bright green, and seem to show a characteristic internal arrangement not seen in *Cylindrocapsa;* the outer investment is also more mucous. As a form, or a form-species, (for, doubtless, such as those belonging to *Cylindrocapsa* and *Hormospora* can all be accounted no more, so long as no reproductive process is known) the present plant (*Cylindrocapsa involuta*) is, *per se*, abundantly distinct. It appears to be very rare, so does *C. nuda*, which I only once met with; neither is recorded by Rabenhorst in 'Flor. Europ.'

"But whether these *Cylindrocapsa-forms* be mere stages of other growths—mere form-species—or permanent parthenogenetic species—they are entitled to hold a place for purposes of reference until happily more be, if ever, known as to their development and their right to rank as independent plants."—*Grev.* III. 40.

Plate IX. fig. 3. Portions showing spores × 400 diam.

Cylindrocapsa nuda. *Reinsch Alg. p.* 67, *t.* 6, *f.* 2.

Undivided cells ellipsoid, membrane thick, without teguments, filaments now and then thickened and enclosing four cells.

SIZE. Tube ·023-·03 mm. diam.

In streams. Ireland.

Cienkowski's* researches on *Cylindrocapsa involuta* achieved such important results that they must be indicated here, since the reproduction will, doubtless, be identical in both species.

"This alga possesses antheridia and oogonia. The oogonium is a globular inflated joint, it consists of contents and wall; the first presents

* Cienkowski, "Zur Morphologie der Ulotricheen," in Melanges Acad. Imp. de St. Petersburg, t. ix. p. 531.

a protoplasmic gonosphere, coloured by chlorophyll, containing numerous starch granules; it presents at one point of the periphery very often a clear spot. The gonosphere is loosely enclosed by the several (3-6) concentric gelatinous (as it were swollen or expanded) membranes. Such oogonia lie either several together, forming a moniliform chain, or they present themselves in the middle of a series of antheridia, or between unaltered vegetative joints, upon which, further on, may abut antheridia. *Cylindrocapsa* is thus monoicous. At both poles of the oogonium the coats are produced into a short cylindrical process; adjoining processes are mutually apposed. The size of the oogonia varies; it may reach ·042 mm., the gonosphere ·024 mm.

"The antheridia are discoid or sphæroidal little cells, like the oogonia possessing a multi-laminated coat, they may form a long series or little groups of pairs; they are often enveloped in twos or fours by numerous laminæ. The contents are clear reddish yellow. The male cells (like the vegetative) are formed by binary division of the mother joint, with the distinction that they cease to grow, remain smaller, and gradually assume the yellowish red colour. Each antheridium developes by division of its contents two spermatozoids. At maturity they are ejected with a jerk; when free, they lie for a while motionless enclosed in their gelatinous envelope. Presently they assume a tremulous motion, at last bursting the vesicle and swimming about. They are protoplasmic fusiform bodies of about ·015 mm. in length, contents sparing, yellowish red; at the anterior hyaline point are borne two flagella, below which are two minute pulsating vacuoles.

"Shortly after their exit they are to be found in the neighbourhood of the oogonia. The whole cavity of the oogonium becomes pushed out laterally, dissolving and leaving an opening at the apex of the expansion. The spermatozoids seem now to be no way aimless in their movements, their whole object being seemingly to effect a penetration; with great energy they drive against the wall, and retreat, and so persist for hours, until at last the movement ceases, and they shrink into formless little masses. The actual confluence of the spermatozoid with the gonosphere was not observed, but the conclusion drawn by the author seems to be legitimate.

"The next change consists in the appearance of a thick gelatinous stratum directly on the surface of the gonosphere, which soon hardens into a doubly contoured membrane. After some days the chlorophyll with the starch granules gradually disappear, becoming replaced by the reddish-yellow oily substance. In this way we obtain from the gonosphere an oospore surrounded by the mucous layers of the oogonium. The author could never see any further development; they lasted the whole autumn and winter without the slightest alteration.

"In some instances the gonospheres on having become enclosed by the gelatinous envelope began to germinate; they divided into two segments, each then becoming clothed by its own gelatinous envelope, and soon divisions followed just as in the ordinary vegetative joints. The author supposes that these still green gonospheres could not have been fertilized, and that only the latter pass over into a state of rest." —*Quart. Journn. Micr. Sci.*, 1877, *p.* 181.

GENUS 17. **HYDRURUS.** *Ag.* (1824.)

Thallus adnate, gelatinous, more or less firm, tubular, elongated (2-4-12 inches long), sometimes variously divided, sticky, surface naked or densely covered with delicate fibres, which at times are fasciculate. Cells in the beginning globose, or subglobose, afterwards elongated, or elliptic, sometimes conoid, one or other pole colourless, arranged more or less regularly in longitudinal families; tegument thick, at length diffluent, cells dividing in one direction, chiefly at the apex or periphery of the thallus. Propagation by means of agile gonidia.

Hydrurus penicellatus. *Ag. Syst. p.* 24.

Thallus rather cartilaginous, olivaceous, of variable thickness, simple and naked below, divided above, and villous with dense fibrils. Internal cells elliptical or somewhat lanceolate; tegument very thin, scarce visible; contents homogenous.

Rabh. Alg. iii. 50.

Hydrurus fœtidus, Vauch. Kirch. Alg. Schl. p. 106.

var. e. **Ducluzelii.** *Rabh. Alg.* III. 50.

Thallus from an inch to a foot long, oftentimes sparingly branched, plumose with very dense fibrils.

SIZE. Cells ·006-·0095 mm. (*Rabh.*).

Hydrurus Ducluzelii, Ag. Consp. p. 27. Hass. Alg. t. 77, f. 3. Rabh. Exs. 176, 873, 1193.

Batrachospermum myosurus, Ducluz. Conf. Montp. p. 76.

Palmella myosurus, Lyngb. Hydr. t. 68, E.

Cluzella myosurus, Bory. Dict. iv. 234.

In alpine rivulets, on stones, rocks, &c.

"Root scutate, blackish, hard. Fronds clustered, solid, very gelatinous, 2-6 inches long or more, 2-4 lines in diameter, freely waving in the water, attenuated towards the apex, branched; branches scattered, alternate, elongate, slender, beset with other more slender, short ramuli. Gelatinous mass pellucid, viscid, colourless under the microscope, without apparent margin, unless as the granules imbedded within its substance indicate such; these are globose, green, formed on the stem and primary branches, most densely set in the ramuli, especially towards the margin. Colour of the recent frond brownish-olive, or dark brown, in drying green; of the granules both recent and dry green."—*Lyngbye.*

Odour in a recent state very offensive.

One or other of the many forms of this species has been called *Palmodactylon subramosum*, Näg., but we have not, as yet, seen any true British representative of that genus.

Plate X. fig. 4. *a*, natural size; *b*, portion magnified 400 diam.

GENUS 18. **NEPHROCYTIUM.** *Näg.* (1849.)

Cells oblong kidney-shaped, with a dorsal chlorophyllose vesicle, 2-4-8-16 associated in free swimming families surrounded by an ample oval or kidney-shaped tegument. Propagation unknown.

Only two European species, both of which have been found in the British Isles. Both are usually found together, and it is possible that hereafter they may be referred back to one species, as Nägeli proposed.

Nephrocytium Agardhianum. *Näg. Einz. Alg. p.* 80.

Cells pale green, almost homogenous, 4-6 times as long as broad, spirally arranged, in families of 4-8 cells; tegument thin which encloses them, length 2-3 times the breadth.

SIZE. Cells diam. ·0038-·0075 mm. (*Rabh.*).

Rabh. Alg. iii. 52. Näg. Einz. Alg. (*forma minor*), t. iii. C. a-h. Kirch. Alg. Schl. p. 112.

In ditches, bogs, &c.

Plate XI. fig. 1. *a, b,* families; *c,* end view; *d,* free cells. All magnified 400 diam.

Nephrocytium Näegelii. *Grun. Rabh. Alg.* III. 52.

Cells dark green, granular, twice as long as broad, irregularly disposed, families usually composed of 16 cells; tegument thick.

SIZE. Cells diam. ·011-·022 mm. (*Rabh.*).

Nephrocytium Agardhianum, majus Näg. Einz. Alg. t. iii. C. fig. i, k, p. Kirch. Alg. Schl. p. 113.

In similar or the same places as the foregoing, with which it is often associated.

Plate XI. fig. 2. *a, b, c,* family groups; *d,* free cells. All magnified 400 diam.

GENUS 19. **OOCYSTIS.** *Näg.* (1855.)

Cells oblong, chlorophyllous, either solitary or binate, quaternate, or octonate; contained at first within an ample simple mother cell, at length free by dissolution of the membrane.

This genus, as Mr. Archer has observed (Micr. Journ., 1877, p. 105), comes very near *Nephrocytium,* the seemingly only very tangible distinction (it is a very constant one at the least), being the reniform (not elliptical) cells in the latter genus; but as forms merely, of more or less frequent occurrence, those referred to both the genera are indeed very distinct and constant.

Oocystis gigas. *Archer, Quart. Journ. Micr. Sci.,* 1877, *p.* 105.

Mother-cell broadly elliptic, almost subglobose, large; family usually consisting of two cells.

SIZE. Mother-cell ·06-·07 × ·05-·06 mm.

In pools. Ireland.

The broadly elliptical cells are very large, and are really subsphærical. "The cell wall," Mr. Archer says, "is by comparison very thick, with the somewhat nodular little thickening at each pole; the chlorophyll granules, in examples in which these were not too dense, could be seen arranged parietally in a beautifully and curiously regular reticulate manner, the 'meshes or interspaces of the interior surface of the wall being bare of them. He had only seen two young cells within theexpanded mother-cell, four, eight, to sixteen being common in *Oocystis Naegelii.* In examples about to produce young individuals, the contents became more dense, and the reticulated arrangements lost, or rather, perhaps, more properly speaking, the interspaces become clothed with chlorophyll granules. At first glance this might be mistaken, under a low power, for that small form of *Eremosphæra viridis*, which originates when the individuals of the ordinary large form produce simultaneously four, in place of two daughter cells; but the evident elliptic figure and the thickened poles, as well as the different arrangement of the chlorophyll contents, would, on closer inspection, at once distinguish them. Mr. Archer has drawn attention to the seemingly curious very great expansion of the wall of the mother-cell, almost looking as if in anticipation, rather than as in consequence of the growth of a young 'brood' of two, four, eight, or sixteen daughter-cells, so much so that it almost had the aspect of a fresh growth, rather than that of a mere swelling up of the old membrane."—*Quart. Journ. Micr. Sci.*, 1877, *p.* 105.

Oocystis setigera. *Archer, in Quart. Journ. Micr. Sci.*, 1877, *p.* 194.

We are unable to give any description of this species which, as far as we are aware, bears only a manuscript name. Neither are we able to give figures of either species, although we hope to do so hereafter.

GENUS 20. **DIMORPHOCOCCUS.** *Br.* (1849.)

Cells united in fours on very short branches, dissimilar, the two intermediate contiguous oblique, obtuse ovate, the two lateral, opposite and separate from each other, lunate; families free swimming, in botryoid clusters.

This genus is allied to *Dictyosphærium*, next to which it should have been placed.

Dimorphococcus lunatus. *Br. Alg. Uni. p.* 44.

Green, apices of the cells hyaline.

SIZE. Cells longitudinal diam. ·01-·02 mm.

Rabh. Alg. iii. p. 36. Archer, Quart. Journ. Micr. Sci., 1872, pp. 195, 197.

Floating in pools. N. Wales.

We have been unable to make a successful drawing from the specimen we possess of this Alga, as we have not seen it living. Mr. Archer, on reporting upon its occurrence in Ireland, criticised the only figure extant (in Rabenhorst's Alg. Eur.) in the following terms: "The upper or outermost cells do not, as they are made to seem, or as the original description might lead one to infer, stand above the larger and lower (inner) cells as upon a common stipes, but the former grow off from the latter, and remain joined thereto by a short pedicle. The inner cels are broadly reniform, and two stand opposite to each other at the apex of the supporting stipes, so as to present a lunate figure, and from the lower part of the sinus made by these it is that the pedicle of each of the pair of secondary, more or less reniform, but unequally lobed, cells (one from each lower cell) starts, the smaller lobes of these latter overlapping each other, and appearing, in a crowded cluster, like one cell, only of smaller dimensions, concentrically posed above the lower cell, and as if on a common stipes, that is, as if all were 'in ramulis —quaternatim conjunctæ.'" The larger lower cells are combined, inter se, by a soft irregular colourless furcated (almost as if shrivelled) stalk, into a crowded colony or family. This branched cluster of cells requires to be broken up and pressed out ere the arrangement referred to can be seen. The structure and mode of arrangement of the cells (which are bright green, with a pale narrow little space at the upper extremity, and with large chlorophyll granules) becomes thus of somewhat complex appearance, nor did it appear to have been made out fully by Braun himself, as conveyed by his description.—See *Quart. Journ. Micr. Science*, 1872, pp. 195, 198.

Genus 21. **MISCHOCOCCUS.** *Näg.* (1849.)

Thallus dichotomously branched, bearing the terminal cells. Cells globose, terminal, geminate or quaternate. Division of cells in one direction. Propagation by zoogonidia.

This genus is confined at present to a single species.

Mischococcus confervicola. *Näg. Einz. Alg. p.* 82.

Cells globose, even, geminate, ternate or quaternate, on the tips of the branches, bright green, delicately granular, destitute of a chlorophyllose vesicle; stem hyaline, spuriously articulated, often swollen at the angles.

Size. Cells ·0045-·009 mm. (*Rabh.*).

Rabh. Alg. iii. p. 54, fig. 29.

Attached to filamentous Algæ in ditches, near Stafford, August, 1849 (Rev. R. C. Douglas).

This interesting little plant is liable to be overlooked on account of its small size and the delicate hyaline stem, only the pair, or more, of little globose green cells being at first visible.

Plate XI. fig. 4. *a*, two plants parasitic on Conferva; *b*, young plants; *c*, terminal branches with 4 cells; *d*, swollen joints of stem; *e*, free cells. All magnified 400 diam.

Family II. PROTOCOCCACEÆ.

Unicellular algæ, in the strictest sense, chlorophyllous, without terminal growth, or ramification, without a vegetative generation of cells. Either single, segregate, or associated in families. Cells of the families either indefinitely increasing in number (then forming *families*) or of a definite number (then forming a *cœnobium*).

Propagation by means of gonidia, arising in the mother cell by free cell formation; gonidia of two kinds, the one larger, *macrogonidia*, the other smaller, *microgonidia;* the former oblong, mostly produced anteriorly into a pale bi-ciliate beak, rounded and greenish at the posterior end, developing into an individual plant; the microgonidia similar to these, and also motile, but passing after a short time into a quiescent state, and at last into resting spores, or hypnospores.

This family is usually subdivided into the following subfamilies:—

1. Protococceæ.
2. Chlorococcaceæ.
3. Polyedrieæ.
4. Scenedesmeæ.
5. Hydrodictyeæ.
6. Ophiocytieæ.
7. Pediastreæ.
8. Sorastreæ.
9. Characieæ.

Many of these small sub-families include but a single genus, so that, in effect, the character of the sub-family is that of the genus; hence they are of little value, especially in a local flora.

Sub-Family 1. Protococceæ.

Cells sphæroid, segregate; cytioderm thin, hyaline, without integument, swimming free, or, when not growing in water, forming a thin pulverulent stratum. Contents in the beginning homogenous, then granular, green, or reddish.

Only one genus has yet found a place in this sub-family, of which one species is British.

Genus 22. **PROTOCOCCUS.** *Ag.* (1824.)

Characters the same as in the sub-family. Propagation by mobile gonidia.

Protococcus viridis. *Ag. Rabh. Alg.* III., 56.

Cells small, segregate, accumulated in a broadly expanded stratum, of a yellowish green colour, either pulverulent, or, during moist weather and after rain, somewhat gelatinous.

Size. Cells ·0025–·004 mm.

On the trunks of trees, fallen branches, and damp walls throughout the year.

It is very probable that this is only a condition of *Pleurococcus vulgaris.*

Plate XII. fig. 1. Cells magnified 400 diameters.

Sub-Family 2. CHLOROCOCCACEÆ.

Cells sphæroid, either single and free, furnished with a chlorophyllose vesicle and a pale lateral spot, sometimes with an ample tegument, or more often accumulated in strata or little clusters. Propagation by zoospores, formed by division of the cell contents, escaping by rupture of the cell wall.

GENUS 23. **CHLOROCOCCUM.** *Fries.* (1825.)

Cells subglobose, single or in clusters. Characters the same as the sub-family.

A. *Species green.*

† *Tegument thin.*

Chlorococcum humicolum. (*Näg.*) *Rabh. Kr. Fl. Sachs*, 137.

Stratum effused, dark-green, pulverulent; cells globose, variable in size, often many united in families, involved in a common hyaline tegument; cell membrane thin, but thickening with age; contents at first pale or yellowish-green, homogenous, at length dark-green, granular.

SIZE. Cells ·017 mm. diam., or less.

Rabh. Alg. iii. 58.

Cystococcus humicola. Näg. Einz. Alg. 85, t. 3, f. E.

On the naked ground (*A. W. Wills*).

Plate XII. fig. 5. Cells and family magnified 400 diameters.

Chlorococcum frustulosum. (*Carm.*) *Rabh. Alg.* III., 59.

Thallus effused, pulverulent, green; cells globose, of medium size, associated in families which are involved in a broad hyaline homogenous envelope.

SIZE. Cells ·007 mm. diam.; families to ·04 mm. diam.

Hæmatococcus frustulosus, Hass. Alg. 380, t. 81, f. 1. Eng. Fl. v., p. 395. Harv. Man. 181.

Palmella frustulosa, Carm. MSS.

On moist rocks.

"It occurs in the form of a greyish black, fragmentary scurf. On the slightest pressure it separates into corpuscles of various forms, but mostly sphærical, hyaline under the microscope, surrounded by a membranous envelope, and including several granules."—*Carm.*

Plate XII. fig. 2. Families magnified 400 diameters.

Chlorococcum murorum. (*Grev.*) *Rabh. Alg.* III., 61.

Thallus crustaceous, yellowish-green; cells subglobose or oblong, with a rather thick hyaline mucous envelope; cell contents æruginous-green, homogenous.

SIZE. Cells, including envelope, ·016-·02 × ·01 mm.

Grev. Sc. Crypt. Fl., t. 325.

Hæmatococcus murorum, Hass. 323, t. 81, f. 4.

On walls.

We have retained this in its present position in deference to Rabenhorst, to whom the species must have been known. At the same time its æruginous green colour seems to indicate an affinity with *Phycochromophyceæ* rather than the present order.

"Plant producing spots on walls and stones of a yellowish green colour, and at first very small, but afterwards indefinitely larger, from a number becoming confluent. First discovered in this country by the Rev. M. J. Berkeley on the freestone walls of Christ College, Cambridge."—*Greville.*

Plate XII. fig. 4. Cells magnified 400 diameters. Some undergoing division.

†† *Tegument thick.*

Chlorococcum gigas. *Grun. in Rabh. Alg., No.* 1436.

Stratum thin, green, mucous; cells globose, large, either single or associated in small families, always involved in a broad, distinctly lamellose hyaline tegument.

Size. Cells ·012-·017 mm. diam. without the hyaline membrane.

Protococcus gigas, Kutz. Phy. Gen. p. 145.

In pools, on walls and glass windows.

One of the finest species in this genus, and possibly not uncommon. We have met with it two or three times, but not in any great quantity. It must not be confounded with *Glœocystis ampla.*

Plate XII. fig. 3. Cells magnified 400 diameters. *b*, in different stages of division.

B. *Species red, rusty, or orange.*

No British species in this section recorded.

Sub-Family 3. Polyedrieæ.

Cells single, segregate, free swimming, compressed, 3-4-8 angled; angles more or less produced, sometimes radially elongated, either entire or bifid, mostly armed, oblong-elliptic when viewed laterally, rounded or rather truncate at the ends. Cell-membrane thin, even. Chlorophyll-mass mostly granular, equally distributed through the cell, sometimes with 1-4 reddish oil-drops. Propagation unknown.

Genus 24. **POLYEDRIUM.** *Näg.* (1849.)

Characters the same as above for the sub-family.

A. *Angles entire.*

Polyedrium gigas. *Wittr. Sotvattensalger, p.* 33, *t.* 4, *f.* 4.

Cells irregularly pentahedrical (rarely hexahedrical), angles obtuse, sides concave.

Size. Maximum diameter of cells ·065-·075 mm.; minimum diameter ·035-·045 mm.

Archer, in Quart. Journ. Micr. Science xvii. (1877), p. 105.

In standing pools.

This large and distinct species has the angles rounded and unarmed.

Plate XIII. fig. 1. *a*, *b*, *c*, cells in three positions, magnified 400, after Wittrock.

Polyedrium tetraedricum. *Näg. Einz. Alg.*

Cells regularly tetrahedrical; angles obtuse, mucronate.

SIZE. Cells ·015–·03 mm. diam.

Rabh. Alg. iii. 62. Archer, Micr. Journ., 1866, p. 62.

In pools.

This might possibly be mistaken for the end view of some species of *Staurastrum*, against which error it is essential that beginners should be cautioned.

Plate XIII. fig. 3. Cells magnified 400 diameters.

B. *Angles radiato-elongated.*

Polyedrium longispinum. (*Perty.*) *Rabh. Alg.* III., 62.

Quadri-radiate, radii thin, elongated, scarcely thickened into a body in the centre.

SIZE. Length of arms ·03–·05 mm.

Phycastrum longispinum, Perty Kl. Lebensf. t. xvi., f. 30.

In pools. N. Wales (*A. W. Wills*).

A peculiar species, which at first sight seems to have but little relationship with the other species figured. It is often found associated with Desmids, and delights in similar localities.

Plate XIII. fig. 2. *a, b, c, d,* cells magnified 400 diameters.

C. *Angles lobed.*

Polyedrium enorme. (*Ralfs.*) *Rabh. Alg.* III., 63.

Cells irregularly tetrahedrical, with the angles produced, hyaline, deeply bilobate; sometimes repeatedly bilobed, with the lobes mucronate.

SIZE. Cells ·025–·04 mm. diam.

Staurastrum enorme, Ralfs, t. 33, f. 11.

In pools.

"Frond very irregular and variable in form. Sometimes the front view differs but little from the end one. Usually, however, there is a slight constriction at the junction of the segments, but I have never observed any difference in the endochrome at that part. The spines, which are almost confined to the angles, are irregular, some simple and some branched. The end view has three or four broad and very irregular lobes; these are spinous and more or less emarginate, and frequently one lobe is much broader and more spinous than the others. The spines on each lobe form two groups, separated by the notch; they vary much in size, and are either simple and subulate, or else forked; sometimes the forked spines are again divided at the apex."—*Ralfs.*

A very variable plant, formerly included with the Desmidieæ, but separated on account of its different mode of propagation.

Plate XIII. fig. 4. Cells magnified 400 diameters. Lateral and end views.

Sub-Family 4. SCENEDESMEÆ.

Cells elliptic, oblong, or cylindrical; cell-membrane very thin; cell-contents at first homogeneous, afterwards granular; chlorophyllose vesicle central or sublateral, and often a lateral colourless spot; cells 2-4-16, either joined in a single series or forming a cœnobium. Propagation by division in the cells whence arise gonidia, which unite themselves into a cœnobium within the mother-cell, and are at length set free by the rupture of the cell-membrane.

GENUS 25. **SCENEDESMUS.** *Meyen.* (1829.)

Cells polymorphous, equal or unequal at the ends, often produced into a spine-like horn. Frond or family composed of from 2 to 8 oblong, fusiform, or elliptic cells, connected into a single or double continuous row; propagating by means of the repeated segmentation, in parallel planes, in one or two directions, of each of the cell-contents into one or more brood families (not motile), set free by the bursting of the parent-cell wall.—*Nägeli.*

A. *Cells unarmed.*

Scenedesmus obtusus. *Meyen. Rabh. Alg.* III., 63.

Cells oblong or ovate, obtuse at the poles, 4-6-8 loosely connected in a simple series, or joined obliquely, 3-5 times as long as broad.

SIZE. Cells ·0055-·007 mm. diam.

Ralfs Ann. Nat. Hist. xv., p. 404, t. 12, f. 8. Brit. Desm. p. 193, t. 31, f. 16. Archer in Pritch. Infus. p. 753, t. 1, f. 37-39. Hass. Alg. p. 394, t. 92, f. 15.

In boggy pools.

This species appears to be much less common than *S. quadricauda,* from all forms of which it may be readily distinguished, not only by the difference in the form of the cells and absence of spines, but the remoteness of one cell from its neighbour and their alternation.

Plate XIII. fig. 5. Cells in families of 4 and 8, magnified 400 diameters.

Scenedesmus acutus. *Meyen. Rabh. Alg.* III., 63.

Cells fusiform or ovate-fusiform, acute at each extremity, 2-4-6-8 united in a series, either single and straight, or double and irregularly alternate; 3-6 times as long as broad.

SIZE. Cells ·0035-·0055 mm. diam.

Ralfs Ann. Nat. Hist. xv., p. 404, t. 12, f. 6. Brit. Desm. 193, t. 31, f. 14. Hass. Alg. 393, t. 92, f. 14.

In pools and boggy places.

var. b. **obliquus.** *Rabh. Alg.* III., 63.

Cells elliptic, fusiform, arranged in two generally oblique series, the outer cell of each not in contact with any of those in the other series.

Scenedesmus obliquus, Ralfs Desm. p. 192, t. 31, f. 15. English Botany, t. 2933.

Scenedesmus triseriatus, Ralfs Ann. Nat. Hist. xv., p. 403, t. 12, f. 7.

var. c. **dimorphus.** *Rabh. Alg.* III., 63.

Cells acute, 4-8, placed evenly in a single row; inner cells fusiform, outer externally lunate.

Scenedesmus dimorphus, Ralfs. Ann. Nat. Hist xv., p. 403, t. 12, f. 5. Brit. Desm. p. 191, t. 31, f. 13. Hass. Alg. 393, t. 92, f. 13.

Formerly the typical form and its two varieties were regarded as three separate species, but there scarcely seems sufficient reason for thus retaining them. Ralfs wrote of them long ago, " When the cells are nearly uniform *S. acutus* has some resemblance to *S. dimorphus;* but in the latter the cells are more slender, never ventricose, and are arranged quite evenly side by side. It is more difficult to distinguish *S. acutus* from *S. obliquus*, and I am far from certain that Ehrenberg erred in uniting them. The principal distinction is that in *S. acutus* the cells form only a single series, which is nevertheless irregular, on account of the alternate projection of the cells in opposite directions. In *S. obliquus*, on the other hand, the cells by division form two distinct rows, which, after separation, become two fronds." These characteristics are better shown in Ralfs' figures than in our own, which are more intermediate, and show an evident approximation to the typical form.

Plate XIII. fig. 6. *a*, cells of the typical form ; *b*, cells of the variety *dimorphus; c*, of the variety *obliquus*. All magnified 400 diameters.

Scenedesmus antennatus. *Breb. Ralf. Desm. t.* 35, *f.* 27.

Cells fusiform, 2-4-8, joined in a single or double series, all somewhat curved, usually ventricose, cuspidate at each extremity, the apices bearing a hyaline globule.

Size. Cells ·0025-·0035 mm. diam., ·013 mm. long.

Rabh. Alg. iii. 63. Archer in Pritch. Infus. p. 753.

In pools.

" *Scenedesmus antennatus* resembles *S. acutus* in form, and also in the arrangements of the cells; but is distinguished from that and every other species by having the attenuated points tipped by minute globules."—*Ralfs.*

At the time the above was written it had not been found in this country, and is still the rarest species, if its specific identity can be maintained.

Plate XIII. fig. 7. Cells magnified 400 diameters.

B. *Cells armed.*

Scenedesmus quadricauda. *Breb. Ralfs Desm.* 190, *t.* 31, *f.* 12.

Cells oblong-cylindrical, each extremity obtusely rounded, 2-4-8, narrowly united, either in a single or double series, all straight, the outer cells at each end (and rarely some of the intermediate ones) armed at each extremity with a recurved spine.

Size. Cells ·0085-·01 mm. diam. to ·022 mm. long.

Rabh. Alg. iii. 65.

Scenedesmus quadricaudatus, Ralfs Ann. Nat. Hist. xv., p. 402, t. 12, f. 4. Hass. Alg. 392, t. 92, f. 12. Jenner Fl. Tun. Wells, p. 200.

In standing water.

The commonest of British species. A variety has been described which differs only in being entirely destitute of bristles. We can confirm Ralfs in his observation that the species of this genus frequently make their appearance in clear water that is kept in glasses or bottles and exposed to the light. He says that he has repeatedly noticed the appearance of *S. acutus* var. *obliquus* in bottles containing *Desmidieæ*, and sometimes its rapid increase so as to outnumber its companions. Specimens obtained in this manner, he adds, are frequently more or less distorted. In little aquaria the present species often becomes a nuisance from its profusion.

Plate XIII. fig. 8. Cells magnified 400 diameters.

Sub-Family 5. HYDRODICTYEÆ.

Individual cells oblong-cylindrical, united into a reticulated saccate cœnobium, all fertile, some producing macrogonidia, which join themselves into a cœnobium within the mother-cell, others producing microgonidia, which are furnished with two vibratile cilia and a lateral red spot; these escape from the parent-cell, and, after a brief motile period, subside into protococcoid, thick-walled spores.

GENUS 26. **HYDRODICTYON.** *Roth.* (1800.)

Characters the same as in the sub-family.

"The genus *Hydrodictyon* comprises, as far as known, but a single species, which is common to North America and Europe. It grows in great abundance in the neighbourhood of Philadelphia, especially in the ditches and stagnant brick ponds in the low grounds below the city, known as the 'Neck.' There it very frequently forms floating masses several inches in thickness, and many feet in extent, so that with the aid of a rake it could be gathered by the bushel. When thus in mass the colour is very generally dingy and yellowish, although the fronds, when in active vegetative life, are mostly of a bright, beautiful green. The plant is in greatest profusion in June and July, after which time it gradually disappears, until in the autumn it is scarcely to be found, but early in the spring it reappears. The very young fronds are minute, oval, cylindrical, filmy-looking closed nets, with the meshes not appreciable to the eye; when growth takes place the fronds enlarge, until finally they form beautiful cylindrical nets, two to six inches in length, with their meshes very distinct, and their ends closed. In the bright sunlight, they, of course, by virtue of the life functions of their chlorophyl, liberate oxygen, which, being free to the interior of the net, and its exit barred by the fine meshes, collects as a bubble in one end of the cylinder, and buoys it up, so that, the heavier ends sinking, the net is suspended, as it were, vertically in the water. I know of few things of the kind more beautiful than a jar of limpid water with masses of these little nets hanging from the surface like curtains of sheen in the bright sunlight. A few cells collected in the fall or early spring, if put into a preserving jar, and the water occasionally changed, will multiply, and in a little while become a source of frequent pleasure to the watcher.

"As the fronds increase in size they are always in some way or other broken up, so that, instead of being closed cylinders, they appear as simple open networks of less or greater extent. The extreme length to which the frond attains is, I think, very rarely over twelve inches, with meshes of about a third of an inch in length. The construction of the frond is always the same. It is composed of cylindrical cells united end to end in such a way as to form polygonal and mostly pentagonal meshes, the size of which varies with the age of the plant. These cells, which are closely conjoined, but have no passage-ways between them, are capable of independent life, so that the *Hydrodictyon* may be looked upon as an elaborate type of a cell-family, one in which cells are conjoined in accordance with a definite plan, so as to make a body of definite shape and size, yet in which each cell is an independent being, drawing nothing from its neighbours. The cells themselves are cylindrical, with a thickish cellulose wall, and having no nuclei. Their chlorophyllous protoplasm is granular, and is placed in the exterior portion of the cell, forming thus, within the outer wall, a hollow cylinder, in which are imbedded starch granules, and whose interior is occupied with watery contents. The *Hydrodictyon* cell, when once formed, is capable of growth, but not of going through the usual process of cell multiplication by division, so that the adult frond is composed of just as many and, indeed, the same cells as it had in its earliest infancy.

"No true sexual reproduction has as yet been discovered in the water-nets. There have been described, however, two forms or methods in which the species multiplies, both of them occurring by means of motile zoosporoid bodies. In the one case these develop immediately into the new plant, whilst in the other, before doing so, they pass through a resting stage. Of the life history of the latter, the *microgonidia*, I have no personal knowledge.

"The investigation of the production and development of the *macrogonidia*, however, has occupied considerable of the time devoted by myself to the microscope, and I have seen large numbers of specimens in almost all the stages of development. I have never been able to detect any decided motion in the *macrogonidia*.

"They are formed in the protoplasmic stratum already alluded to as occupying the outer portion of the interior of the *Hydrodictyon* cell. The first alteration in this, presaging their formation, is a disappearance of the starch granules, and a loss of the beautiful transparent green colour. Shortly after this, even before all traces of the starch-grain are gone, there appear in the protoplasm numerous bright spots placed at regular intervals; these are the centres of development, around which the new bodies are to form. As the process goes on, the chlorophyl granules draw more and more closely around these points, and at the same time the mass becomes more and more opaque, dull, and yellowish brown in colour. This condensation continues until at last the little masses are resolved into dark hexagonal or polygonal plates, distinctly separated by light, sharply defined lines. In some the original bright central spot is still perceptible, but in others it is entirely obscured by the dark chlorophyl. The separation of these plates now becomes more and more positive, and they begin to become convex, then lenticular, and are at last converted into free, oval, or globular bodies. When these are fully formed they are said to exhibit a peculiar trembling motion, mutually crowding and pushing one another, compared by A. Braun to the restless, uneasy movement seen in a dense crowd of people in which no one is able to leave his place. Whilst the process just described has been going on, the outer cellulose wall of the *Hydrodictyon* cell has been undergoing changes, becoming thicker and softer and more and more capable of solution, and by the time the gonidia are formed it is enlarged and cracked, so that the room is afforded them to separate a little distance from one another within the parent-cell. Now the movements are said to become more active—a trembling jerking which has been compared to the ebullition of boiling water. There is, however, with this a very slight change of space, and in a very short time the gonidia arrange themselves so as to form a little net within the parent-cell, a miniature in all important particulars of the adult *Hydrodictyon.* The primary cell wall now becomes more and more gelatinous, and soon undergoes complete solution, so that the new frond is set free in its native element.

"It is evident that when the species is multiplied in the way just described the birth of the new frond is consentaneous with the death of the old cell. But when the *Hydrodictyon* disappear in the fall, it is months before they reappear in the spring. It is, therefore, evident there must be some other method of reproduction. This slow development of new fronds takes place, according to Pringsheim, by means of little motile bodies which he calls *Dauerschwarmer*, which has been translated in English *Chronispores* (*statospores*, Hicks). M. Braun stated already some years since that sometimes, instead of the *Hydrodictyon* producing the ordinary reproductive bodies (*macrogonidia*), there are formed in the cells much smaller and more active bodies, the *microgonidia.* The changes which occur in the production of these are very similar to those already described as happening when the macrogonidia are formed. When the *chronispores* are formed, however, they, instead of uniting together, escape in a free, distinct condition with the water. They are now small ovate bodies, with a large anterior transparent space, to which are attached a pair of cilia, and their life and history, according to Pringsheim, is as follows:—For a few hours they move about very actively in the water, and then, dropping their cilia, and acquiring an outer cellulose wall, pass into a quiescent stage, in which they closely resemble *Protococcus* granules. They are capable of living in this state for a long time if kept in water. They can also endure dessication if the light be excluded during the process, but if it be present, they wither and die, and cannot be revivified.

"After a longer or shorter period, but never shorter than three months, according to Pringsheim, they recommence their life, provided they be in water. For four or five months after this the chief change consists simply in an increase in size. The dark green protoplasm is arranged around the exterior of the cell; within are the more fluid colourless contents, the whole body still looking like a *Protococcus* cell. After a size of about $\frac{1}{40}$th mm. is attained, the endochrome divides successively into several portions. The external layers of the surrounding wall now give way in some spot, and allow the inner layers to protrude and form a sort of hernial sac, into which the several endochrome masses soon pass, at the same time assuming the well-known characters of true zoospores. From two to five of these bodies are thus produced out of each original microgonidium. They are large, ovate, biciliate, and, generally, soon escaping from the hernial sac, move about actively in the water for a few minutes. Sometimes, however, they settle down within the generative utricle. In either case, after a little time, they become motionless, lose their cilia, and develop into polyhedral cells, which are structurally remarkable for having their angles prolonged into long, horn-like appendages. Under favourable circumstances, at the end of a few days, the bright green endochrome of these undergoes similar changes to those described as presaging the production of the microgonidia, and is finally formed into zoospores, which, in from twenty to forty minutes, unite, within the polyhedron or large cells, into *Hydrodictyon*, which is finally set free by a solution of the cellulose coat of the polyhedron. The network thus formed differs in no essential way from that which arises in the better known way, except that it is composed of much fewer cells. It is generally a closed sac; but when the polyhedron, out of which it is developed, is small, it is sometimes merely an open network. Its after-history appears to be identical with that of the ordinary *Hydrodictyon* frond."—*Dr. H. C. Wood,* "*American F. Water Algæ.*"

Hydrodictyon utriculatum. *Roth. Rabh. Alg.* 66.

Size of the families (net) variable; also of the cells (forming the meshes) and the gonidia, according to circumstances.

Eng. Flora v., p. 359. Harv. Man p. 140. Eng. Bot. (Ed. 2) t. 2504. Hook. Scot ii. 80. Gray. Arrang. i., p. 300. Hass. Alg. 225, t. 58.

Conferva reticulata, Dillw. Conf. t. 97. Eng. Bot. (Ed. 1) t. 1687. Huds. Ang. ii. 596. Relhan Cant. 444. Hull Br. Fl. 331. Abbot Bedf. 275. With. iv. 132. Ray Syn. p. 59. Dillen. Musc. 20, t. 4, f. 14.

In clear water.

For the development of this species see remarks under the genus, and also an elaborate account in Braun on Rejuvenescence, pp. 137, 171, 190, 197, 222, and 261. Observations by Cohn "Der Mikroskopischen Algen und Pilze," p. 109, and Pringsheim "Dauerschwärmer des Wassernetzes" (Berlin, 1861).

Plate XIV. fig. 1. *a*, "Water net," natural size; *b*, one of the "meshes" magnified; *c*, cell with microgonidia × 300, after Cohn; *d*, portion of cell with angular macrogonidia × 300, after Cohn; *e*, free macrogonidia; *f*, active macrogonidia × 600.

Sub-Family 6. OPHIOCYTIEÆ.

Cells cylindrical, unæquipolar, at first short, then elongated, either variously curved and contorted, sometimes circinate, one or other pole attenuated into a thin, short stem, free swimming; either straight or more or less curved, collected in an umbel with a simple stem, or being repeated, forming a composite umbel. Cell-contents parietal, homogenous or granular, green, sometimes mixed with scattered reddish or brownish globules. Propagation by gonidia.—*Rabh. Alg. Eur.* iii. 66.

GENUS 27. **OPHIOCYTIUM.** *Näg.* (1849.)

Cells cylindrical, at first short, then elongated, variously curved, sometimes circinate, attenuated at one extremity into a short, thin stem; free swimming. Propagation by division of cell-contents and formation of gonidia.

Rabenhorst unites the following genus with the present, giving to it the characters of the sub-family, but we have preferred to follow A. Braun and keep them distinct.

Ophiocytium cochleare. *Br. Alg. Unic. p.* 54.

Slender, pale green, often very long, filiform, variously curved, circinate, or more or less loosely spirally involved; stem short, spine-like, acute or truncate; contents homogeneous.

SIZE. Cells ·005-·0075 mm. diam.; length variable.

Archer, Micr. Journ. 1866, p. 63. Rabh. Alg. iii. 67.

Ophiocytium, "Science Gossip," June, 1867, p. 127, fig. 103.

In pools, mixed with other algæ.

Plate XIV. fig. 2. *a*, young cells; *c*, older cells; *b*, mature cell × 400.

Genus 28. **SCIADIUM.** *Braun.* (1855.)

Plant from a single individual producing a family. Thallus (solitary) adnate, unicellular; cell elongated, cylindrical, straight, attenuated at the base into a slender stem. Gonidia about 8, resulting from division of the cell-contents, at length protruding from the ruptured apex, retained at the mouth and extending in the form of an umbel, each individual becoming developed into a cylindrical cell like the mother-cell. This process is repeated to a third, or sometimes a fourth generation, forming a composite or decomposite umbel. Ultimate cells producing free biciliate zoogonidia.

The cylindrical cell of *Sciadium* possesses uniformly distributed green contents, which are interrupted, in perfectly developed cells, by light cross streaks, and are divided into a row of 5 to 8 about equal masses, which become gonidia. I could not detect nuclei in the individual segments of the contents passing into the formation of gonidia.—*Braun Rejuvenescence*, p. 260.

Sciadium arbuscula. *Braun Unicell. Alg. p.* 106, *t.* 4.

Umbellate. Cells straight (rarely falcate), obtuse at the apex; stem about as long as the diameter of the cells.

Size. Cells ·0038 mm. (rarely ·007 mm.) diam.

Sciadium arbuscula, Micr. Journ., 1866, p. 4. Archer, Micr. Journ. xii., 1872, p. 314.

Ophiocytium arbuscula (Br.), Rabh. Alg. Eur. iii. 68.

Attached to confervoid algæ and aquatic plants.

Braun, writing of this species, says—" It displays an originally obovate tube, generally becoming elongated into a cylindrical form, obtuse above, and prolonged into a slender attached pedicel below. The contents consist of uniformly green mucilage, in which a small vesicle may sometimes be distinguished, but only in the earliest stage of growth. The pedicel is transparent and colourless, and secretes at its base an originally yellowish brown, afterwards dark brown mass, which gradually expands into a disc-shaped foot. When the growth is completed the green contents become divided into several masses, developing into a series of 5-8 germ cells; the cell membrane dehisces, throwing off its summit as a finger-stall-shaped cover, but the germ cells, instead of leaving the open tube, all collect at the point of exit with their inferior, narrower, and somewhat pedicellately elongated ends sticking in the tube. Thus is produced a capitule, and by the advancing growth of the young family an umbel formed of individuals exactly resembling the parent individual from which they originated. The emptied mother-cell tube remains as the stem and support of the umbellate family, and gradually becomes filled from above downwards with the same yellow and reddish brown secreted substance which it exhibits at its own base. The imperfect birth of the germ cells just described is repeated at the transition to the third, and mostly even to the fourth generation, so that little arborescent groups are produced with twice or thrice-repeated umbellate ramification, till at length the cells which form the outermost umbellules scatter out their germ cells, which, after a short swarming, fix themselves again to be developed into ramified stocks of new families "—*Braun Rejuvenescence*, p. 187.

Plate XV. *a, b*, young cells; *c*, commencement of the first generation of daughter-cells; *d*, further progress of the first generation of progeny; *e*, second generation being evolved from the first; *f*, old plant evolving a third generation × 300, after Braun; *g*, zoogonidia.

Sub-Family 7. PEDIASTREÆ.

Cœnobium discoid, plane.

For other features of this sub-family see the characters of the genus, which is the only one at present comprised within it.

GENUS 29. **Pediastrum.** *Meyen.* (1829.)

Cœnobium plane, frond-like, discoid, or stellate, free swimming, formed of cells in a single, rarely in the centre in a double stratum, continuous, or with the cells here and there interrupted, perforate or clathrate. Cells polygonal, central entire or slightly emarginate, those of the periphery entire or two-lobed, the lobes wedge-shaped, either simple or two-toothed, sometimes elongated into a horn. Cell-contents green, homogeneous at first, then granular.—*Rabh. Alg. Eur.* iii. 69.

Formerly this genus was included in Desmidiaceæ, but the knowledge of its life history has shown that it has no relationship with the Conjugatæ. Braun illustrated the development of one species (Rejuvenescence, Pl. III.), and we have reproduced some of his figures (on Pl. XVI.) Fig. 1 is an old disc, in great part emptied by the birth of gonidia. Several of the empty cells exhibit a cross slit, through which the contents have been discharged. The order in which this emptying took place is indicated by the letters *a, b, c, d, e*. One cell is in the act of discharging the gonidia, these having in part entered the projecting portion of the hernia-like vesicle, formed by the swollen innermost layer of the membrane of the mother-cell, in part still remaining in the internal cell cavity. Three other cells still possess their perfect contents in different conditions. Two of them are filled by sixteen extremely closely crowded gonidia, only half of which are visible, as they form a double layer. The third unemptied cell is in the actual transition to the formation of gonidia. It exhibits the first division of the contents into two halves, one of which already appears halved again. Fig. 2 is a new-born family immediately after the birth. The innermost layer of the mother-cell has wholly emerged from the old cell, as an extremely thin vesicle, enclosing the gonidia, the gonidia in the interior moving actively. Fig. 3 is the same family, as seen from the upper surface. Fig. 4 is the same family, a quarter of an hour after birth. The gonidia, now at rest, have arranged themselves in a plane disc. Fig. 5 is the surface of the same family at the same stage. Fig. 6 the same family one hour after birth. The emargination of the cells has proceeded further. Fig. 7 the same again, but four hours after the gonidia ceased to move. The emargination of the border-cells has passed into the formation of horns. The cells are not even yet closely connected together, but exhibit spaces between them, so that in this stage it resembles *P. pertusum*. Not until the second day do the cells become closely applied together; the horns acquire their proper shape and length at the same time. All the figures are magnified 400 diameters.

The number of cells which enter into the composition of a single disc vary in the same species, so that it cannot be accepted as a character. The arrangement and limit of species adopted are those proposed by Braun ("*Algarum unicellarum*," 1855).

Plate XVI. figs. 1 to 7. Development of *Pediastrum*, after Braun; 8 *a*, *b*, zoogonidia.

SECTION 3. *DIACTINIUM*. *Braun*.

Cells of periphery emarginate or bilobate, lobes entire.

Pediastrum selenæa. *Kutz.* *Rabh. Alg.* III. 73.

Cœnobium orbicular, entire, formed of 8-16 (rarely 31) cells. Cells of periphery narrow, lunate, acutely lobed; cells of disc slightly excised, central one five-angled; substance firm, rather thick.

SIZE.* Cœnobium ·028-·085 mm. diam.

Braun Unicell. Alg. p. 83. Ralfs Desm. t. 21, f. 5.

Pediastrum Napoleonis, Ralfs Ann. N. Hist. xiv. (1844) t. 12, f. 6.

Pediastrum elegans, Hassall Alg. t. 86, f. 19.

Pediastrum lunare, Hassall Alg. t. 92, f. 3.

In bogs, moor pools, &c.

Plate XVI. fig. 9. *a*, 8-celled cœnobium; *b*, 16-celled cœnobium × 400 diameters; *c*, marginal cell.

Pediastrum angulosum. *Ehr.* *Rabh. Alg.* III. 73.

Cœnobium orbicular, oblong, or subreniform, continuous, composed of 8-16-32-64 cells. Cells all even, angular, those of the periphery truncate at the base and dilated upwards, more or less deeply notched in the middle, the lobes obliquely truncate, outer angle very shortly apiculate, inner one ending in a short horn. Central cells 5-6 angled, slightly repand in front, marked with a small transverse oblong pallid spot.

SIZE. Cœnobium ·12 mm. diam.; cells ·019 diam.

Hass. Alg. t. 86, f. 14. Ralfs Desm. t. 31, f. 11 *a b*. Braun Unic. Alg. p. 84.

Pediastrum Boryanum, Ralfs Ann. Nat. Hist. xiv. (1844) t. 12, f. 7, upper.

Pediastrum excavatum, Hassall Alg. t. 92, f. 6.

In bogs.

Plate XVI. fig. 10. *a*, marginal cells; *b*, 16-celled cœnobium; *c*, 8-celled cœnobium × 400 diameters.

* The size must depend on the number of cells of which the cœnobium is composed; hence throughout this genus the dimensions given must only be accepted as approximate.

Pediastrum Boryanum. *Turp. Rabh. Alg.* III. 74.

Cœnobium orbicular, oblong, or elliptic, variable in size, continuous, bright green, composed of 4-8-16-32-64 (rarely 128) cells. Cells of periphery more or less deeply emarginate, or two-lobed, lobes horn-like, horns colourless, short or long, straight, obtuse or nearly so, sometimes a little thickened; central cells very closely concrete, 4-6 angled, angular or truncate in front, or slightly repand; membrane decussately punctate.

SIZE. Cells ·02-·002 mm. transverse diam.

Braun Unic. Alg. p. 86. Ralfs Ann. Nat. Hist. xiv. (1844) t. 12, f. 7, lower. Ralfs Desm. t. 31, f. 9 *a*. Hassall Alg. t. 86, f. 13.

Pediastrum hexactis, Hassall Alg. t. 92, f. 5.

Pediastrum Napoleonis, Ralfs Desm. t. 31, f. 7 *a* and *d* (short-horned form); f. *b* (long-horned form).

Pediastrum simplex B. cruciatum, Ralfs Desm. t. 34, f. 15 *d*.

Pediastrum granulatum, Braun "Rejuvenescence," pl. 3, 4 (English edition). Pritch. Infus. t. 1, f. 59-69.

In boggy pools.

Plate XVI. fig. 11. *a*, 4-celled cœnobium; *b* and *e*, 16-celled cœnobium; *c*, 32-celled cœnobium; *d*, 8-celled cœnobium × 400 diameters.

var. B. **granulatum.** *Kutz.*

Cells as in the preceding, but all the cells and the horns distinctly granulated.

Braun Unicel. Alg. p. 90.

Pediastrum granulatum, Ralfs Desm. t. 31, f. 8.

In the same localities.

Plate XVI. fig. 12. *a*, *b*, 8-celled cœnobia × 400 diameters.

Pediastrum bidentulum. *Br. Unic. Alg.* p. 91.

Cœnobium orbicular or oblong, continuous, deep green, sometimes bluish green, nearly blue, composed of 16-32 cells; cells of periphery two-lobed to the middle, lobes straight, produced into a truncate, bidentate horn; central cells 4-5 angled, slightly repand in front.

Rabh. Alg. iii. 77.

Pediastrum ellipticum, var. *β*., Ralfs. Desm. t. 31, f. 10 *a*, *b*, *c*.

In boggy pools.

Distinguished by the marginal cells being divided into two obtuse lobes, resembling blunt horns, each of which is two-toothed.

Plate XVII. fig. 1. *a*. part of a 32-celled cœnobium; *b*, larger 32-celled cœnobium, after Ralfs, × 400 diameters; *c*, 16-celled cœnobium; *d*, marginal cell.

Pediastrum constrictum. *Hass. t.* 86, *f.* 15, 16.

Cœnobium orbicular, or nearly orbicular, bright green, continuous, smooth (?), composed of 16-32 cells; cells of the periphery irregularly two-lobed, sinus narrow, lobes unequal, now and then constricted at the base, produced into an obtuse, rather thick horn; central cells polygonal, repand in front.

Rabh. Alg. iii. 77.

Pediastrum ellipticum, Ralfs Desm. t. 31, f. 10 *d*.

Pediastrum Boryanum, β., Ralfs Ann. Nat. Hist. xiv. (1844) f. 8.

In standing water.

Braun suspects the verity of this species, which we have never seen.

Plate XVII. fig. 2. *a*, 32-celled cœnobium; *b*, 16-celled cœnobium × 400 diameters, after Ralfs; *c*, marginal cells.

Pediastrum gracile. *Br. Unic. Alg.* p. 93.

Cells quaternate, closely joined in a circle, centre open, rarely closed; cells deeply two-lobed, lobes ovate, produced into a long divergent, acuminate horn.

Rabh. Alg. iii. 75.

Pediastrum simplex, Ralfs Desm. t. 34, f. 15 *a b*.

In pools.

This appears to be a very rare species, at first referred to *P. simplex* Meyen, from which it differs in the cells, being deeply two-lobed.

Plate XVII. fig. 3. 4-celled cœnobia × 400 diameters, after Ralfs.

Pediastrum pertusum. *Kutz. Phy. Germ.* p. 143.

Cœnobium orbicular, pierced with lacunæ, of variable size, composed of as many as 64 cells; cells of the periphery loosely connected at the base, bilobed almost to the middle; lobes straight, produced into a hyaline horn, sometimes acute, sometimes obtuse or truncate; central cells more or less exactly quadrangular, emarginate in front, even, with two paler spots.

Size. Perfect cells ·016-·022 mm. transverse diam.

Rabh. Alg. iii. 75. Ralfs Desm. t. 31, f. 6 *a*, *b*. Braun Unicell. Alg. p. 92.

Pediastrum Napoleonis, Ralfs Desm. t. 31, f. 7 *c* and *e*.

Pediastrum selenæa, Kutz., Pritch. Inf. t. 1, f. 53.

In pools.

Plate XVII. fig. 4. *a*, *b*, *c*, 8-celled cœnobia; *d*, 32-celled cœnobium; *e*, 16-celled cœnobium.

var. *b.* **clathratum.** *Br. Unicell. Alg. p.* 93.

Disc pierced with larger openings; central cells deeply notched and bilobate.

Pediastrum cribriforme, Hassall Alg. t. 92, f. 4.

Plate XVII. fig. 5. 16-celled cœnobium.

var. *c.* **brachylobum.** *Braun Unicell. Alg. p.* 93.

Cells larger, those of the periphery emarginate or triangularly notched, shortly two-lobed; horns very short, truncate, or almost obsolete; cells of the disc perforated with smaller openings.

Pediastrum tricyclum, Hassall Alg. t. 92, f. 1.

Pediastrum Napoleonis, Hassall Alg. t. 92, f. 10. (?)

Plate XVII. fig. 6. *a*, 5-celled cœnobium; *b*, 16-celled cœnobium, fig. 4; *f*, marginal cell.

SECTION 4. *TETRACTINIUM*. *Braun.*

Cells of periphery emarginate or bilobate; lobes emarginate, bidentate, or bifid.

Pediastrum Ehrenbergii, *Br.* *Rabh. Alg.* III., 72.

Cœnobium orbicular or oblong, perfectly closed, composed of 8-16 cells, or quadrate, of 4 cells, which are wedge-shaped, deeply lobed and arranged in the form of a cross; cells of the periphery cuneate, truncate at the base, deeply bilobate; sinus narrow, lobes obliquely truncate, more or less notched, interior angles twice as long, all acute, or shortly appendiculate; central cells yellow green, polygonal, one side repand or deeply notched.

Pritch. Infus. t. 1, f. 52.

Pediastrum tetras, Ralfs Desm. t. 31, f. 1. Ralfs Ann. Nat. Hist. xiv. (1844) t. 12, f. 4. Hassall Alg. t. 86, f. 17.

Pediastrum heptactis, Ralfs Ann. Nat. Hist. xiv. (1844) t. 12, f. 5. Ralfs Desm. t. 31, f. 2.

Pediastrum simplex, Hassall Alg. t. 86, f. 18 ~~8, f. 17~~.

Pediastrum biradiatum, Ralfs Desm. t. 31, f. 3, 4.

In pools and boggy places. Not uncommon.

Very variable in size. The 4-celled cœnobia are often to be met with, mixed with Desmids and other Algæ.

Plate XVII. fig. 1. *a*, four-celled cœnobia; *b*, 8-celled cœnobia; *c*, 8-celled cœnobium of nnusual form, after Ralfs.

var. *a*. **truncatum**. *Braun Unicell. Alg.* p. 97.

Lobes truncate.

Pediastrum biradiatum, Ralfs Desm. t. 31, f. 4.

Plate XVIII. fig. 1. *b*, 8-celled cænobia.

var. *b*. **excisum**. *Braun Unicell. Alg.* p. 97.

Lobes slightly notched, emarginate.

Plate XVIII. fig. 1. *d*, 4-celled cœnobium; *e*, 8-celled cœnobium; *i*, *k*, 16-celled cœnobia.

var. *c*. **cuspidatum**. *Braun Unicell. Alg.* p. 97.

Lobes deeply notched, evidently bidentate or bicuspidate.

Pediastrum biradiatum, Ralfs Desm. t. 31, f. 3.

In stagnant water, throughout Europe generally.

Plate XVIII. fig. 1. *g*, *h*, cœnobia; *f*, marginal cell.

Pediastrum rotula. (*Ehr.*) *Br. Unicell. Alg. p.* 101.

Cœnobium orbicular or oblong, size and number of cells variable, 4-8-16-32, pierced with openings, bright green, even; cells of the periphery truncate at the base, more or less dilated upwards, deeply bifid, sinus acute, lobes straight, narrow, bidentate, teeth erect or divergent, somewhat bent; cells of the centre variable in form, usually polygonal, repand, or notched, containing a single paler spot, sometimes not visible.

Rabh. Alg. iii. p. 79.

Pediastrum heptactis, Hassall Alg. t. 92, f. 9.

Pediastrum incisum, Hassall Alg. t. 92, f. 8.

In pools, &c., throughout Europe.

Plate XVIII. fig. 2. *b*, marginal cell; *a*, 4-celled cœnobium; *c*, 6-celled cœnobium; *d*, 8-celled cœnobium; *e, f, h*, 16-celled cœnobium; *g*, irregular cœnobium.

Sub-Family 8. SORASTREÆ.

Cells polygonal, often shortly horned, associated in a hollow, sphærical or cubical cœnobium; cell-membrane thin; cell-contents green, homogeneous, then granular; chlorophyllose vesicle central or sublateral. Propagation by gonidia, in two modes in the same species (simultaneous, or after division), united into a cœnobium within the mother-cell, escaping by rupture of the membrane.—*Rabh. Alg. Eur.* iii. 79.

GENUS 30. **CŒLASTRUM.** *Näg.* (1849.)

Cœnobium globose, hollow within, formed of a single stratum of cells, reticulately pierced.—*Rabh. Alg. Eur.* iii. 79.

Frond, or family, hollow, globular, or subcubical, composed of polygonal or sphærical cells, united in one layer into a hollow clathrate net-like family, the cells drawn out on the exterior into one or more lobes, or simply sphærical; propagating by the segmentation of the cell-contents into a definite number of portions which become arranged into a hollow young frond, resembling the parent, ultimately set free by the bursting of the parent cell.—*Pritch.* 755.

Cœlastrum sphæricum. *Näg. Ein. Alg.* 97.

Cœnobium globose or subglobose, composed of 4-8-16 or a larger number of cells, perforated, areolæ 3-4-5-6 angled; cells rounded, by mutual pressure angular, outer angles somewhat conical, obtusely rounded at the apex; interstices 5-6 angled.

SIZE. Cœnobium ·04-·085 mm. diam.; cells ·021-·023 mm.

Cœlastrum Naegelii, Rabh. Alg. iii. 79. Archer in Pritch. Infus. p. 755, t. 1, f. 49-55.

In boggy places.

Plate XIX. fig. 2. *a, b*, families magnified 400 diameters; *c*, cell magnified 800; *d*, cell of *C. cubicum*, with two obtuse processes; *e*, cell of *Cœlastrum*, perhaps *C. cambricum*, with one obtuse process.

Cœlastrum cambricum. *Archer Micro. Journ.*, 1868, *p.* 65.

Cells rounded on the exterior margin, each bearing a single truncate tubercular process.

. In pools.

"It was obtained by Mr. Archer on his visit to Wales, and is not referable to either of the remaining forms (besides *C. sphæricum*) as described by Nägeli, though perhaps showing most affinity with *Cœlastrum cubicum*, but differing in each cell possessing but one process, or tubercle-like appendage, not three. These likewise showed various conditions of the growth of the young cœnobia within the mother-cells from the earliest stage, the most minute of which showed the full character of the cells, each with the truncate tubercle-like process."—*Quart. Journ. Micro. Soc.*, l.c.

Cœlastrum microsporum. (*Näg.*) *Braun Alg. Unic. p.* 70.

Cells 8-16 or 32, exactly sphærical, containing a single globule; interstices small.

SIZE. Cœnobium ·04 mm. diam.; cells ·009 mm. diam.

Micr. Journ., 1868, p. 65. Pritchard's Infus. f. 755.

In bogs and pools.

"The group (cœnobium) is formed of rather large cells, externally globularly rounded, their margins, where in mutual contact, being straight, and leaving at the angles exceedingly minute, somewhat triangular interspaces, like very minute pores, leading into the central cavity characteristic of the forms appertaining to this genus."—*Archer.*

GENUS 31. **STAUROGENIA.** *Kutz.*

Cœnobium cubical, hollow within, formed of 4-8-16 quadrate or sub-quadrate cells. Propagation by quiescent gonidia, produced after the subdivision of the cell-contents.—*Rab. Alg. Eur.* iii. 80.

Crucigenia, Morren in Ann. des Sci. Nat., 1830, t. 20, p. 404.

Staurogenia rectangularis. *Braun Alg. Unic. p.* 70.

Cells oblong-oval, 4-16-64, associated in tabular families, almost twice as long as broad, angles obtusely rounded.

SIZE. Cells ·0075 × ·004 mm.

Archer in Quart. Journ. Micr. Sci., 1875, p. 206.

In pools.

Plate XVIII. fig. 3. *a*, families × 400; *b*, magnified 800.

GENUS 32. **SORASTRUM.** *Kutz.* (1845.)

Cœnobium globose, solid within, free swimming, formed of 4-8-16-32 compressed wedge-shaped cells, which are sinuate, emarginate, or bifid at the apex, and radiately disposed. Propagation unknown.—*Rabh. Alg. Eur.* iii. 81.

The family (or cœnobium) in this genus is solid, and not hollow as in *Cœlastrum*, composed of wedge-shaped or heart-shaped cells, somewhat compressed and united into globose families, the narrow ends meeting in the centre, with the outer margin emarginate or divided.

Sorastrum spinulosum. *Näg. Einz. Alg. p.* 99.

Cœnobium spinulose, cells wedge-shaped, apex slightly emarginate, angles obtusely rounded, bi-spinulose.

SIZE. Cœnobium to ·04 mm. diam.

Archer Micr. Journ., 1866, p. 124. Pritch. Infus. t. 1, f. 56-58. Rabh. Alg. iii. 81. Reinsch Algenflor. p. 86, t. 5, f. 6.

In stagnant water.

Plate XIX. fig. 1. *a, b,* families magnified 400 diameters; *c,* side view of cell; *d,* front view of same.

GENUS 33. **SELENASTRUM.** *Reinsch.*

Cells semilunate, joined together by the middle of the convex margin, in families of 4-8, regularly disposed. Propagation unknown.—*Reinsch Algenflor. Frank. p.* 64.

Selenastrum Bibraianum. *Reinsch Algenflora p.* 64.

Cells semilunate, with the cusps either expanded or curved inwards; minor families constituted of four cells in pairs, major families of these combined in more or less sphærical masses.

SIZE. Cells ·016-·023 mm. long × ·005-·008 mm. diam.; minor families ·023-·031 mm. diam.

In moor pools.

Plate XIX. fig. 3. *a,* families magnified 400 diameters; *b,* pair of cells magnified 1000 diameters.

Sub-Family 9. CHARACIEÆ.

Cells always innate, often distinctly stipitate, variable in form; cell-membrane delicate, growing thicker with age (then double membrane visible); cell-contents bright green, homogenous, afterwards always granular, with one starch granule, ultimately divided. Propagation by repeated binary division of the cytioplasm, resulting in more or less numerous biciliate zoogonidia.—*Rabh. Alg. Eur.* iii. 81.

GENUS 34. **CHARACIUM.** *Braun.* (1847.)

Cells oblong, ovate, pyriform, fusiform, rarely acicular or subglobose, equal or oblique, erect or inclined, attenuated at the base in a hyaline stem. Cell-contents green, homogenous or granular, zoogonidia, succeeding division of the cytioplasm, more or less numerous, occupying the whole of the cell, at length greatly agitated, escaping by a lateral (rarely terminal) rupture, oblong, with two vibratile cilia.—*Braun Unicel. Alg. p.* 29.

Characium Sieboldi. *Br. Alg. Unic.* 32 *t.* 3, *f.* A. 1-21.

Cells erect, equal, at the beginning nearly lanceolate, when older pyriform or obovate, 2-3-4 times longer than broad, apex obtuse or broadly rounded; stem short, hyaline, base attenuated, truncate, not discoid; contents bright green or yellowish-green, granular, in the beginning with a single amylaceous granule, afterwards with several.

SIZE. Cells ·022-·026 mm. diam.

Rabh. Alg. iii. 83.

In clear water, attached to filiform algæ. Bangor (*W. Joshua*).

"The gonidia of this species exhibit, after they have already attached themselves by their ciliated extremities, a tremulous motion lasting for almost a quarter of an hour, and evidently commencing in the delicate stalk."—*Braun p.* 230.

Plate XX. fig. 9. Cells in various stages, *in situ*, × 400; 10, cells containing mature zoogonidia; 11, free zoogonidia.

Characium ornithocephalum. *Br. Alg. Unic. p.* 42, *t.* 3 C.

Cells from the beginning unequal, incurved, distinctly stipitate, afterwards one side swollen, semilunate, apex produced into a straight or inclined beak; stem elongated, slender, base sometimes discoid; cell-contents bright green, granular, with a central or lateral starch granule.

SIZE. Cells ·025-·033 mm. long, without stem, half as wide, or more.

Micr. Journ., 1867, p. 85. Rabh. Alg. iii. 86.

In pools.

Plate XIX. fig. 5. *a*, young cells; *d*, cell further advanced; *b*, *c*, *f*, mature cells in different stages of division; *e*, mature cells with endochrome artificially contracted, all magnified 600 diameters.

Characium tenue. *Herm. in Rabh. Beitr. p.* 26.

Cells erect, narrowly lanceolate, six times as long as broad, attenuated towards each extremity, somewhat rostrate, and hyaline above; stem short, slender, not dilated at the base; contents homogenous, bright green.

SIZE. Cells ·003-·006 mm. diam.

Micr. Journ., 1866, p. 126, 193.

Characium ambiguum, var. *c.*, Rabh. Alg. iii. 87.

Attached to filamentous algæ.

Plate XIX. fig. 4. Cells magnified 400 diameters.

GENUS 35. HYDRIANUM. *Rabh.* (1864.)

Cells as in *Characium*, but cell-contents at the beginning homogenous, afterwards contracted into a dark green ovoid corpuscle, from which, by oblique division, 2-4-8 biciliate zoogonidia are produced, which escape by a terminal aperture.—*Rabh. Alg. Eur.* iii. 87.

Hydrianum heteromorphum. *Reinsch contrib. p.* 80.

Cells at first globose-elliptical, attenuated below into a thin hyaline stem; contents granular, then contracted in preparation for formation of the gonidia; zoogonidia elongated, escaping at the broadly opened apex.

SIZE. Cells, unopened, ·008-·0095 mm. broad; opened cells ·0066 × ·02 mm.

Reinsch Contributiones ad Algologiam (1874) p. 80, t. 11, fig. 3.

Attached to filamentous algæ.

Plate XIX. fig. 6. *a*, cells in different stages attached to a filamentous alga magnified 400 diameters; *b*, young cells; *c*, mature cells magnified 800; *d*, cell with zoogonidia escaping, and magnified 1200 diameters; *e*, zoogonidia further magnified.

GENUS 36. **CODIOLUM.** *Braun.* (1852.)

Cells at first obovate, as they grow older becoming clavate, or nearly cylindrical, densely aggregated in tufts, base attenuated into a stem; cell-contents green, delicately granular, mixed with numerous starch granules. Propagation by zoogonidia, and also by resting spores (hypnospores).—*Braun Unic. Alg. p.* 19.

Codiolum gregarium. *Br. Alg. Unic. p.* 20.

Cells elongated, subclavate, green; many times longer than the diameter, apex rounded.

SIZE. Cells ·03 mm. diam.

Rabh. Alg. iii. 90.

On maritime rocks (*E. M. Holmes*). Also in the drip of fresh water.

Some persons contend that this is only a marine plant, others that it occurs also in the neighbourhood of the coast, but either in æstuaries or entirely removed from salt water. We include it here without prejudice to either opinion.

Plate XX. fig. 1, 2, 3, young plants; 4, 5, further developed plants; 6, mature plants × 300 diameters, one containing starch granules, the other mature zoogonidia; 7, 8, zoogonidia.

Family III. VOLVOCINEÆ.

Cœnobia mobile, globose, subglobose, or quadrangular and flattened, produced from agile biciliate green cells, with a double contractile vesicle. Common tegument of the cœnobium hyaline, more or less ample.

Propagation sexual or asexual. The sexual monœcious or diœcious, either all or some of the cells of the cœnobium exhibiting male and female characters. Male cells containing spermatozoids (*antheridia*), the female finally changed into a quiet oospore. Non-sexual propagation by means of motile gonidia (macrogonidia and microgonidia). These arise from the simultaneous and repeated division of the cell contents (*cytioplasm*). Macrogonidia definite in number (2, 4, 8, 16, &c.), the larger oblong or rounded, with the anterior extremity more or less rostellate, with two cilia exserted through the membrane of the vesicle, furnished with a parietal red spot (*eye-spot*), and often two contractile vacuoles. Microgonidia indefinite in number, much smaller, pale or dull green, or yellowish, with cilia at the apex, mostly even within the mother-cell, endued with rapid motion, and ultimately escaping by rupture of the membrane.

Pritchard's "Infusoria" (p. 144) may be consulted with advantage, although including some genera which undoubtedly belong to Infusoria. Also the various memoirs hereafter referred to under the several genera.

The passage into amæboid conditions has been observed in several genera, but this is a subject on which further investigation is needed. T. C. White has seen it in *Chlamydococcus* ("Journ. Quekett Micr. Club," 1879), Archer in *Stephanosphæra* ("Quart. Journ. Micr. Sci.," 1865, p. 127), and Dr. Hicks in *Volvox* ("Quart. Journ. Micr. Sci.," 1860, p. 99, and 1862, p. 96).

Genus 37. **CHLAMYDOCOCCUS.** *Br.* (1849.)

Cells globose, or subglobose, (4-8 joined in a very fugitive cœnobium), cell-membrane thickish, firm, cell contents granular, brownish red or vermilion, in certain stages changing into green. Macrogonidia 2-4-8 rounded, the frontal extremity bearing very long cilia, and furnished with a central reddish nucleus and four to six starch granules (not always visible) involved in a very ample, hyaline, mostly ovoid tegument. Microgonidia much smaller, numerous, yellowish or dull green, the apex reddish, biciliate, moving actively within the mother cell, and at last escaping, by rupture of the membrane.

Chlamydococcus pluvialis. *Br. Rejuvenescence, p.* 206.

Cells subglobose, very variable in size, brownish red, changing in some conditions to green.

SIZE. Cells ·007-·035 mm.

Rabh. Alg. Eur. .iii, 93. Cohn Nova Acta. xxii. p. 749, t. 67 A. B. Pritchard Infus. 523, t. xix. f. 20-31. T. C. White, in "Quekett Microscopical Journ.," vi. p. 43.

Hæmatococcus pluvialis. Flotow, Nova Acta xx.

Hæmatococcus Corda. Meneg. Nost. p. 20, t. 1, f. 5.

Hæmatococcus mucosus. Morren Rubefact : des Eaux, t. 6, f. 10-20.

Protococcus pluvialis. Kutz. Tab. i. f. 1. Cohn, Memoir on Protococcus.

Protococcus monospermus. Corda, in Sturm Flora ii. 25.

On rocks, stones, &c., in hollows filled with rain water.

"Normally fully developed cells of this multiform creature, sometimes like a plant, sometimes like an animal, present the appearance of globules from ·02 to ·04 mm. diam., with a thick, tough cell membrane, and granular-punctate, opaque contents, sometimes of a brown, sometimes (at other periods, or in other localities) bright red colour. In the mass of the dark contents lie hidden several other structures, which at this period are completely concealed, namely 4-6 starch globules of ·0033 or at most ·005 mm. in diameter, in which, as in those of *Hydrodictyon*, a nucleus and an envelope may be distinguished, acquiring a violet colour with iodine, the nucleus becoming rather redder. Sulphuric acid causes a considerable swelling up of the coat. There also appears to exist in the centre of the cell a large, very delicate nuclear vesicle, which, however, is so covered up by the rest of the cell contents, that it can only be very indistinctly perceived, and cannot even be clearly displayed when the contents are squeezed out. When these resting globular cells are placed in water they give birth to four gonidium-like swarming cells. Even before the commencement of the division of the contents by which the latter are formed, a change begins in the colour of the parent cell, the red colour retreating to some extent from the periphery, and a yellow (sometimes rather greenish) border forming round the deep red inner mass. The young swarmers also, for a short time after they issue out, have only a narrow yellow rim round a dark red middle. During the two or three days' period of movement and growth of these swarming cells—in which they grow to about four times the original size, changing their obtusely ovate form at the same time to a reversed pear-shaped apiculated shape—important new changes take place in the contents of the cells. The red colour becomes more and more concentrated into the middle of the cell, so that a sharply defined bright red nucleus is formed, in the interior of which a lighter space is often clearly perceptible, corresponding to the nuclear vesicle above-mentioned, around which the red colouring matter forms a covering, mostly complete, but sometimes imperfect and interrupted. The rest of the cell contents have become a brilliant green, and in them may be clearly distinguished the above-mentioned starch granules, as well as many more smaller green granules. The ciliated point of the cell, often drawn out like a beak, is colourless. This first moving generation is succeeded by a not yet accurately determined number of similar active generations populating the water for some weeks, and often giving it a bright green colour, till at length universal rest recommences, and the cells sink to the bottom, or attach themselves to the sides. The transition from one active generation to another takes place through a transitory resting generation of extremely short duration. The full-grown swarming cells finally come to rest within their wide shirt-like envelope, and almost simultaneously divide into two cells, which, without becoming active, divide again into two cells. Thus within the mother envelope are produced four daughter-cells (more properly grand-children), which begin to move soon after they are completely formed, and, tearing open the delicate enveloping vesicle, part company. The whole of this process of development is gone through very rapidly, being completed in one night and the succeeding morning. The second active generation, thus formed, resembles the first, with the single distinction that the active cells are green from the first, and have a smaller red nucleus in the interior. The subsequent active generations bear a general resemblance to the preceding, but many modifications present themselves. Thus, for example, we not unfrequently see the full-grown swarm-cells assume strange two-lobed, or even four-lobed, shapes, beginning to divide before they come to rest; or sometimes a transverse constriction and bisection of the cell takes place, caused by a partial protrusion of it from the loose shirt, &c. The formation of vacuoles is a pretty constant phenomenon in the later active generations, and there may be several of them eccentrically placed, with the red nucleus retaining its central position, or a single central vacuole, causing a lateral displacement of the red nucleus. This red nucleus often becomes very small in the last generations, so that it very much resembles, especially when rendered parietal by the formation of a central vacuole, the red corpuscle occurring in the gonidia of many genera of Algæ belonging to very diverse families, and which was called the 'eye' in the *Volvocineæ* by Ehrenberg.

"A total disappearance of the red colour not unfrequently occurs. In the later stages of the cycle of generations arrives, finally, the formation of microgonidia; many individuals, instead of producing four daughter-cells, undergo further division, so as to give birth to a brood of 16 or 32 minute cells, which, before they separate, form a mulberry-like body, but separating at length, commence a very active swarming inside the parent envelope, terminating in the rupture of this coat and the rapid dispersion of the little 'swarmers.' These are of longer shape than the large 'swarmers,' only about ·0066, rarely ·01 mm. long, of yellowish or dirty yellowish green colour, with reddish ciliated points. They do not exhibit increase of size, like the large 'swarmers,' never become coated with a perceptible and loose membrane, and have no further power of propagation. Most of them die after they have settled to rest, dissolving away; others turn into little red globules, and it is doubtful whether they can grow up to the normal size. If we now further examine how the cycle of active generations is closed and carried over to the resting vegetation, we find that the large 'swarmers' of the last active generation, when their growth is completed and they have attained the stage of rest, instead of dividing again remain undivided, assume a perfectly globular form, and in the course of a few days become clothed by a thick, closely applied cell membrane, while the earlier loose distant membrane gradually disappears. The contents, which at the commencement of the rest were all green, except the little red nucleus, or even often entirely green, now gradually become red again, passing from green through many tints of brown, or of brilliant golden green and golden brown, into red. These globular, thick-coated cells (the same as those with which we began) behave like seed-cells or spores, passing into a state of perfect rest. They do not exhibit any growth, and after the membrane has attained its proper thickness, and the contents their red colour, no further visible alteration takes place so long as they are kept in water. A dessication must take place before a new cycle of generations can begin. Perfectly dry specimens placed again in water ordinarily produce active gonidia the next morning. Original specimens obtained in 1841 had retained their vital force during a preservation of seven years in a herbarium.

"In order to complete the main features of the picture of the alternating generations of this multiform creature, I must notice that, in addition to the described active generations (macrogonidia and microgonidia) and the concluding generation, passing into the spore-like condition of rest, there are other generations which, as compared with the gonidium-like and spore-like conditions, must be regarded as the proper representatives of the vegetative development. These are generations endowed with quiet and slow vegetative growth, which multiply by pure vegetative division, unaccompanied by any swarming movement. It depends solely upon external conditions whether the resting cells, which are here characterized as seed-cells (spores), at once give rise to the new active generations, or to a series of quietly vegetating generations of cells. The former is the case when the seed-cells are totally immersed in water, the latter when they occur on a spot which is at once damp and exposed to the air, as is the case in the native condition, especially in the milder intervals of winter, and in the damp season of approaching spring, but temporarily also at all other seasons, on the margins of the little basins inhabited by *Chlamydococcus*, as often as they are filled by showers of rain. In cultivation in the house these vegetative generations are rarely observed, while in their native stations they certainly occupy the most important place in the alternations of the various conditions of life, as may be concluded from the thickness of the crusts and membranes formed by such vegetative multiplication. The formation and multiplication of these vegetative generations also take place by the division of the cell contents, either by simple division, the first generation being transitory, or by double halving (apparently quartering). But the newly formed cells do not slip out, like the young 'swarmers,' from the mother envelope; they remain in the same place and position. The membrane of the mother-cell appears to become softened, expands, and becomes gradually drawn out to nothing, rather than regularly burst open; it at length vanishes in some undistinguishable way, the daughter-cells meanwhile acquiring a tolerably thick, closely applied cell membrane of their own. The division is repeated many times in this way, and as the cells all remain in intimate contact, first small families, but by degrees large conglomerates of cells are produced. The size of the single cells in these groups varies from ·01 to ·02 mm.; their shape is not truly globular, but partly bounded by flat surfaces, as results from the alternating divisions, according to the three directions of space. Ordinarily the colour is light brown. If ignorant of the rest of its history, one would be led by the form and mode of division of the cells to regard these crusts as belonging to a *Pleurococcus*. In the same crusts occur isolated large cells, loosened from their connection with the others, perfectly globular in form, and appearing to divide no more, but to have passed again into the condition of resting spore cells. They are distinguished from the rest by their darker contents and thicker cell membrane. Probably the return of these to renewed resting vegetation takes place by a passage through the series of active generations. Every shower of rain will wash away these loose ripe cells of the crusts of *Chlamydococcus*; carried into collections of rain water, they will soon produce the active brood, which, returning to rest after a few active generations, settles on the margins of the little puddles, and then recurs to the resting mode of vegetative multiplication."

The foregoing life-history is somewhat abridged from the account given by Braun ("Rejuvenescence," pp. 206-214), and for further details the reader is referred to the Memoir by Flotow ("Nova Acta Naturæ Curiosorum," Vol. xx. p. 11), and that by Cohn (translated in "Memoirs" by the Ray Society, 1853), which will furnish all that can be required, and are really exhaustive. For remarks on an Amæboid condition see paper by T. Charters White in the "Journal of the Quekett Microscopical Club" for 1879.

Plate XXI. fig. 1. *a*, still cells × 400; *b*, green cell with chlorophyll vesicle, and reddish nucleus; *c*, a cell which had been dried six years, undergoing segmentation after revival; *d*, completed division; *e*, division into four; *f*, naked green zoospore; *g*, encysted zoospore; *h*, primordial cell, commencing division in two; *i*, encysted zoospore, which has deliquesced; *j*, primordial cell dividing in four; *k*, encysted zoospore in still condition; *l*, division of still cell into 8 cylindrical zoospores; *m*, escaped zoospore; *n*, division of encysted cell into 4; *o*, division into 8; *p*, division into 32; *q*, zoospores from the latter form escaped from mother-cell; *r*, large red still cell dividing into segments; *s*, red encysted cell; *t*, yellow-green still cell. All after Cohn.

Chlamydococcus nivalis. *Br. Rejuv. p.* 206.

Cells globose, red, at first with a hyaline border, which is the thickened epispore, which gradually disappears with age.

SIZE. Cells ·01-·03 mm. diam.

Rab. Alg. Eur. iii. 93.

Hæmatococcus nivalis, Ag Icon. Alg. t. 31.

Protococcus nivalis, Ag. Supp. p. 13. Hook. Eng. Fl. v. p. 395. Mackay Hibern. p. 246. Hass. Alg. p. 335, t. 83, f. 2. Harv. Man. p. 182. Grev. Sc. Crypt. Fl. t. 231.

Palmella nivalis, Hook, in Parry's Voy. App. p. 328.

Tremella nivalis, Brown, in Ross Voy. Supp. p. 44.

Uredo nivalis, Bauer. Journ. Sci. and Art vii. p. 222, t. 6.

On snow and wet rocks, &c.

Probably not specifically distinct from *Chlamydococcus pluvialis*. For the history of this minute plant, long known as "Red Snow," consult "Greville's Scottish Cryptogamic Flora," Vol. iv. plate 231. The interesting observations by Agardh and others, there detailed, are too long for quotation here.

Introduced to the notice of botanists in this country on the return of Capt. Ross from Baffin's Bay, where it was found extending for some miles, it was regarded by Bauer as a fungus, by Robert Brown as an Alga, and by Baron Wrangel as a Lichen. Agardh first included it in Algæ, under the name of *Protococcus nivalis*.

It has been found in this country "on the borders of the lakes of Lismore, spreading abundantly over the decayed reeds, leaves, &c., at the water's edge, but in greater perfection on the calcareous rocks within the reach of occasional inundation, more or less perfect at all seasons of the year."—*Carm.* Also in Ireland.

Plate XXI. fig. 2. *a*, still cells × 400; *b*, cell divided in two; *c*, cell divided in four; *d*, advanced stage of subdivision in four; *e*, encysted zoospore; *f*, free zoospore; *g*, resting cell.

GENUS 38. **CHLAMYDOMONAS.** *Ehrb.* (1833.)

Macrogonidia ovate or oblong-rounded, green, delicately granulated, involved in a rather narrow hyaline tegument frontal extremity very obtuse, or somewhat truncate, with a contractile vacuole, and two cilia; posterior extremity with a large chlorophyllose vesicle, and with or without a red lateral spot. Microgonidia arising from repeated division of the cytioplasm of the macrogonidia, oblong or ovate, numerous, pale green or yellow, becoming brownish. Tranquil oospores globose, red or brownish, contents firm, colourless, hyaline.

" *Chlamydomonas* is distinguished from *Chlamydococcus* by the closely applied membrane (not standing away from the contents) of the old swarming cells, also by the absence of the little starch-vesicles in the interior, while, however, as is usual in most of the *Palmellaceæ*, a single large 'chlorophyll utricle' (starch utricle ?) exists in the interior. There is no central red nucleus, as in the gonidia of *Chlamydococcus*, but some species have a parietal red spot. The motion is affected by two cilia, as in *Chlamydococcus*. As in that genus, there is a growth of the gonidia during 'swarming,' which lasts over the day and night. There is also a formation of microgonidia. The species of this genus are doubtless very numerous, but the distinction of them among themselves, as well as from the swarming cells of many other Algæ, is very difficult without a complete acquaintance with the history of their lives. The species *Chl. obtusa*, occurs in the Rhine valley, near Freiburg, in sand pits, which are occasionally almost completely dried up in summer. The macrogonidia grow during their period of swarming from ·016 to almost ·033 mm. long; they are longish, of equal diameter on both sides, and very obtuse, almost truncated, having a colourless place at the ciliated extremity, presenting the form of a notch. In regard to other points, the contents are dark green, finely granular, with a large vesicle at the posterior extremity, a roundish lighter space in front of this, and no red point. They multiply by simple or double halving in several successive generations. Sometimes a further continuation of the division of the full-grown macrogonidia occurs, forming sixteen or thirty-two macrogonidia from ·005 to ·008 mm. long, of ovate shape and lighter colour, tending towards brownish yellow. The resting cells are globular, about ·025 mm. in diameter, at first green, subsequently light yellowish brown, finally flesh-red; they have a tough, colourless, and transparent membrane. Another species, *Chl. tingens*, occurs in enormous quantity in the puddles of the sandstone quarries at Lorettoberg, near Freiburg, in the month of March, in mild seasons sometimes even in January and February. The swarming cells are smaller than in the preceding, ·008 to ·016 mm. long, ovate, lighter green, likewise destitute of a red spot, and the membrane is more distinct in the old age. Increase by double, rarely by simple halving, in the former case with decussating sections.

"Several species of this genus, previously included in the animal kingdom, but nearly allied to *Glæococcus* and *Chlamydococcus*, present themselves in the beginning of spring, in such abundance that they produce a striking green colouration of the water; a few weeks later they vanish, leaving no trace, and are not noticed again throughout the whole year."—*Braun Rejuvenescence, p.* 215.

Chlamydomonas pulvisculus. *Ehr. Infus. p.* 64.

Macrogonidia ovate, twice as long as broad, or nearly; deep green, with a bright red lateral spot.

SIZE. Diam. ·0065-·013 mm.

Rabh. Alg. Eur. iii. 94. Cohn in Nova Acta. xxiv. t. 18, f. 28. Fresenius Beitr. 235, t. 11, f. 43-45. Pritchard Infus. 521, t. 18, f. 40, 51-54.

Diselmis viridis, Dujard. Zoophy. 342 iii. f. 20, 21.

In stagnant water.

"These creatures form a large portion of the green matter which colours the water contained in water-butts, ponds, and puddles in the summer and autumn, especially after a storm. Whenever these exist in large quantities, multitudes of them, and of their envelopes, rise to the surface of the water, and form a green stratum upon it."—*Pritchard.*

Plate XXI. fig. 3. *a*, swarmspore; *b*, *c*, encysted and undergoing division; *d* to *g*, glœocystis forms; *h*, resting cells, after Cieņkowski × 400; *i*, stellate cyst, from Stein; *j*, individual differentiated; *k*, swarming × 600.

GENUS 39. **VOLVOX.** *Linn.* (1758.)

Cœnobium sphærical, continually rotating and moving, looking like a hollow globe, composed of very numerous cells arranged on the periphery at regular distances, connected by the matrical gelatin; furnished with a red lateral spot, two contractile vacuoles, and two long exserted cilia, all circumscribed within a common hyaline vesicle. Propagation sexual or non-sexual. In the non-sexual certain distant cells greatly enlarge, divide into numerous parts, and evolve daughter-cœnobia within the parent-cœnobia, which are ultimately set free. In sexual propagation certain masculine cells undergo a multipartite division into fascicles of mobile spermatozoids, which are contractile, pear-shaped, and biciliate, afterwards free. The female cells are enlarged, but do not undergo division; after fertilization they develop into motionless oospores, which are finally red, surrounded by a double epispore.

The following is a summary of the structure and life-history, of *Volvox* as given by A. W. Wills in the "Midland Naturalist" (Sept.-Oct., 1880):—

"It seems hardly necessary to describe the normal aspect of this organism. Briefly, under a low power, it is seen to consist of a sphærical globe of mathematical perfectness, so transparent that, as it glides along, any object over which it passes is clearly visible through its vacant spaces, *i.e.*, through such parts as are not occupied by the structures presently to be noticed, while by focussing the binocular on the lower half of the plant the effect is obtained of looking into the inside of a glass sphere of crystalline purity and of absolute symmetry. The diameter of a full-grown Volvox is usually about 1-60″, and individuals are to be found in each colony varying from this down to about 1-80″. The *inner* surface of the sphere is studded at intervals with dark green points, not disposed irregularly, but so arranged that each is usually the centre of a group of six others, placed at the extremity of nearly equal radii. These green points are '*gonidia*,' each probably endowed with the potentiality of becoming a perfect Volvox, though only a certain number of them actually undergo that sequence of changes which results in their becoming fresh individuals resembling the parent sphere.

"Each gonidium is either sphærical or pyriform (in which case its pointed end is directed outwards), and contains, in its early stages at any rate, one or more contractile vacuoles disposed among a mass of granular endochrome, and stated by Busk to pulsate rhythmically once in about forty seconds. (Plate 23, Fig. 6.)

"At this period are also to be seen in the body of the gonidium one, two, or three—occasionally even more—brilliant colourless spots, from one of which is probably derived a nucleus which can be detected by the use of reagents at a later period.

"There is also often lodged within the substance of the zoospore a brown or red '*eye-spot*,' and all the eye-spots in an individual look, so to speak, one way.

"The apex of each gonidium is more or less produced into a transparent point, from which proceed two cilia several times as long as the gonidium itself, which pass through two minute pores in the outer cell wall, and move freely in the surrounding water. I am fortunate in having mounted a specimen of Volvox, in which these pairs of *foramina* are clearly shown, and the regularity of their disposition at a uniform angle to the equator of the sphere is striking. (Plate 23, Fig. 7.) It is, of course, by the combined action of these numerous pairs of cilia that the whole organism progresses. Of the direction of the resultant motion we shall speak shortly.

"Viewing the surface of the sphere with its convexity presented to the objective, we find, by very careful adjustment of light, that from each gonidium there runs to each of the six surrounding ones a fine thread, sometimes double, occasionally triple, always of extreme tenuity (Plate 22, Figs. 1 and 3), of *such* tenuity, indeed, as to be frequently invisible; but as the use of certain reagents often brings these lines into view where it had been previously impossible to detect them, and as they may be sometimes discerned for an instant when the eye is applied fresh and unfatigued to the microscope where even a moment later they seem to be absent, it may be assumed that the structure is universal, though often far too subtle to be detected. It is needless to say that no skill of the draughtsman can even suggest its infinite delicacy, while the figures given in books, not excepting the beautiful drawings in Ehrenberg's 'Infusionsthierchen,' exaggerate the strength of the connecting lines to the extent of grossly caricaturing the extreme fineness of Nature's own handiwork.

"To return to the gonidia and their history. A certain number of these in each individual are selected to produce a group of young Volvoces within the parent sphere. The books fix this number as usually four or eight; but out of twenty-five individuals now in the field of my microscope I find only three containing four incipient spheres of the second generation, while only one contains eight, and there are four containing five, six with six, ten with seven, and one with nine such progeny. Almost every Volvox, when first discharged from the parent sac, and possessing a diameter of about 1-170'', already contains a certain number of enlarged gonidia, destined in due time to become its own progeny. Not only so, but long before its discharge, and while yet it exists as a daughter-cell within the protecting cavity of the parent generation, these selected gonidia are already visible as spots larger and darker than their fellows. (Plate 22, Fig. 1.)

"The history of these selected gonidia, as it may be traced in a daughter-sphere recently cast forth to seek its fortunes in the world of waters around it, is as follows:—The enlarged gonidium is at first a flat, thin circular disc, appressed to the internal surface of the sphere, and being surrounded by *eight* of the ordinary zoospores, is derived from the coalescence of the two central ones out of a group of ten. (Plate 23, Figs. 1, 1*a*.) Shortly, this disc assumes a more distinctly oval form, with a slight constriction across its lesser diameter, in which stage it often much resembles a young Cosmarium. (Plate 23, Figs. 2, 2*a*.) It is soon seen to be clearly subdivided into four, and its thickness having grown *pari passu* with its superficies, the group now protrudes into the internal cavity of the parent-plant. (Plate 23, Figs. 3, 3*a*.) Repeated subdivision now goes on rapidly (Plate 23, Figs. 4, 4*a*), till the whole body assumes a sphærical form, a distinct cell wall being at the same time formed, which is revealed by careful illumination, and still more clearly by the use of reagents, as a hyaline sphere concentric to and of larger diameter than the green one within it, so that there appears to be a clear space or ring between the two when seen in section. (Plate 22, Fig. 5, 5*a*.) Finally, the young Volvox consists of a vast number of deep green granules closely packed together, and by mutual pressure driven to assume a more or less distinctly hexagonal form, and corresponding in number to the gonidia which are to stud its surface when its growth is completed. Shortly hereafter, the whole organism continuing to increase in size, clear spaces appear between the gonidia, *showing that the enlargement of the cell wall and its interspaces is outstripping that of the gonidia*, which are now approaching maturity. The interlacing connecting threads are developed simultaneously. (Plate 22, Fig. 1*a*.) During the whole process the centre of the young Volvox spheres continually recedes from the periphery of the parent, so that when the group of young ones has attained the full development of which it is capable in this stage they are often pretty closely packed in the internal space, and sometimes even slightly deformed by mutual pressure, each by this time closely resembling the parent in miniature, and already containing enlarged gonidia of the third generation. (Plate 22, Fig. 1.) By this time the clear space originally visible between the gonidia and the cell wall has been obliterated, and the cilia may be seen protruding through the latter. Some writers state that the daughter-cells rotate at this period within the parent cavity. I have frequently seen them oscillate so far in one direction and then back to their original position, but have never observed a true rotatory motion. Finally, the young Volvoces are liberated by the rupture of the parent sac, at a *special point, clearly marked out for this purpose in its structure*. I have not met with any observations on this point, but have fully convinced myself that it may always be predicted at what point this rupture will be effected.

"The combined action of the pairs of cilia in which the gonidia terminate is the actuating power whence proceed both the rotatory and the progressive movement of Volvox, and these are both in a definite direction. If an imaginary axis be drawn through the sphere, the progressive motion being, so to speak, from the north to the south pole of that axis, *the rotatory motion is usually from west to east*, though not always, being occasionally reversed for a few seconds; but for the greater part of the time it is regularly in the direction indicated, and the *point of rupture of the sphere will be at its north pole.*

"It is difficult to determine precisely how this rupture is accomplished, but I believe it to be by a special contraction of the walls of the parent, or of the invisible primordial utricle, *not* by the outward pressure of the daughter spheres, this force being evidently inadequate to produce the result where their number is small, whatever it may be when it reaches its maximum.

"Shortly before the emission of the young the cell commonly assumes a slightly pyriform shape, and then slowly opens at its apex, but *the aperture is of less diameter* than that of the young Volvoces, and as each of these passes out, the mouth of the bag is visibly stretched, and resumes its original size after each daughter sphere has escaped, so that it evidently possesses considerable elasticity, a property also made manifest by the fact that the normal form of Volvox may be considerably flattened by the pressure of a glass cover, and yet resume both its sphærical form and its motion when this pressure is removed.

"Moreover, the daughter sphere passes out *without rotating*, and from whatever cause it derives its impulse, this often suffices to drive the young Volvox clear of the mouth of the sac to a distance equal to several times its own diameter, in which position it pauses motionless for some seconds, and then, commencing to rotate gently, sails away, at first slowly, then more and more rapidly, to enjoy its independent existence.

"After the rupture of the sac, the gonidia near the edges of the opening are seen to quiver, from the action of the cilia, where they are partially freed from the support of the surrounding envelope, and the same thing occurs when they are forcibly torn from their attachment, in which case they may even move for awhile freely through the water.

"The general action of the cilia continues for some time, and the empty sphere rotates as before, its general direction being still from north to south, with the open end to the rear. After a time, which I cannot specify, the cilia cease to play, and the organism decays, having fulfilled its destiny in life.

"The birth of the young Volvoces is affected by various circumstances. Doubtless the process is, under natural conditions, most active in the early hours about dawn, when the analogous functions of similar organisms are well known to be most energetic, but in order to see the phenomenon in full vigour it is only necessary to place a number of mature parent-spheres, such as are found in every colony, in a shallow live-trough, and to bring them into a warm room. In an hour's time almost all the young plants will have been liberated. Light and heat stimulate the action, while cold and darkness retard it. The ciliary action is affected in a remarkable degree by altered external conditions. If a drop of water considerably colder than that in which the Volvoces are floating be allowed to flow in under the cover-glass, the whole are paralysed for some seconds, after which they slowly resume their motion. A sudden mechanical shock produces a similar effect. A sufficient degree of heat to make the water distinctly tepid to the feel causes instant and simultaneous death of the whole colony.

"During the day the majority of the Volvoces contained in a shallow vessel rise to the surface, although they avoid strong direct sunshine, while at night they retire in a cloud to the bottom.

"The astonishing number in which the spheres at times appear in some pool, and their equally sudden disappearance, have been frequently remarked. Doubtless a very slight change in external conditions suffices on the one hand to favour the development of countless thousands of young plants, and on the other, either to destroy the vitality of the whole colony or to drive it to seek refuge in deeper water.

"A curious instance of this sensitiveness to varying conditions of light and heat occurred to myself. I had two shallow vessels in a north window, each containing a goodly supply of Volvox. Cold and inclement weather, which prevailed for weeks together, seemed to check their increase, for I found but few young spheres from day to day among the older ones. Thinking that a moderate degree of warmth would tend to increase my colony, I transferred one vessel, fortunately not both, to the floor of a warm greenhouse. In forty-eight hours all were dead, and in a few days scarcely a vestige remained of the countless corpses which had copiously strewed the bottom of the glass.

"We must now revert to the minute structure of the mature parent-sphere, which has been exhaustively studied by Cohn, Busk, and Williamson.

"In the outset it should be stated that the last-named observer believes that there are two distinct forms of Volvox, in one of which the peculiar structure which I am about to describe exists, while it is absent from the other. Busk disputed the accuracy of Williamson's observations on this point, but in an appendix published subsequent to the body of his essay he states that he has detected this same structure in specimens from Manchester, but *not* in his own.

"I have failed to develop it by the means recommended by Williamson, but have succeeded in making it evident enough in a great number of specimens from Sutton, by the use of these reagents, and especially by the application of aniline purple, an invaluable auxiliary in the examination of minute vegetable cell-structures.

"This substance stains the protoplasmic elements of such structures to a colour which appears deep purple by direct light and crimson by dark background illumination, and reveals details which are wholly invisible without its use.

"The colour is, however, greedily absorbed by some of the materials used by the microscopist, so that a judicious choice of these is necessary to ensure success. Objects stained in this manner are, for instance, rapidly bleached if mounted in gold-size cells, and I have for the present adopted zinc-white in its place. Among other reagents which I have used are eosin, iodine, iodised glycerine, carmine solution, potassium permanganate, nitrate of silver, and other salts, some of which bring into view various parts of the minute structure of plants; but aniline colours, applied with due precautions, produce the most rapid and striking effect.

"Professor Williamson describes the structure in question as a net-work of lines dividing the whole surface into hexagons, in the centre of each of which is seated one of the gonidia.

"The delicate 'protoplasm-threads' proceeding from each of these to its six surrounding neighbours never pass through the angles of the hexagons, but always through the side of each hexagon to the next gonidium. (Plate 23, Fig. 3.) Hence it appears that 'the points of adhesion are chosen prior to the development of the outer cell membrane,' in which light Williamson regards the hexagonal division. In his specimens this structure was developed by immersion in glycerine for some time. I have failed to obtain more than the faintest suggestion of it by these means, but it is often brought out by the application of aniline purple, as is also an important detail shown in drawings made from his preparations, viz., that at the angles of the contiguous hexagons there is sometimes a distinct doubling or separation of the lines, whence he concludes that each side of the figure is really formed by two delicate cell-walls in close juxtaposition, the duality of which is only made evident by the action of reagents. (Plate 22, Fig. 2.) He regards the globe of Volvox as a 'hollow vesicle, the walls of which consist of numerous angular cells filled with green endochrome, &c., the intercellular spaces being more or less transparent,' and the ciliated zoospore as representing the endochrome of a cell having two walls, the *internal* one being separated from the outer cell-wall, except at a few points where it is retained in contact by the connecting filaments, and the *external* one forming the hexagonal divisions on the surface. He further holds that the periphery of the sphere, when seen in section, has an appreciable thickness, its inner margin being definite and parallel to the outer one; and that the sides of the hexagons being continued downwards through the thickness of the outer membrane, the appearance of all these structures, if they could be seen simultaneously, would be that shown in Plate 23, Fig. 6.

"Even in deeply stained specimens I have never been able to detect the existence of these hexagons as other than an entirely *superficial* structure, and at present my impression is that the hexagonal structure has a different significance.

"In the very early stage of Volvox-life the embryo gonidia are encased in a distinct transparent outer-sphere. (Plate 23, Fig. 5, 5*a*.) At a later period. owing to the more rapid growth of the gonidia than of the case, the latter closely invests the former, which are, in fact, embedded in it. In the next stage, if not in the earlier condition, by the continued growth of the gonidia at a *greater rate* than that of the containing sphere, they are so closely appressed as to assume the hexagonal form, and the interstices must of necessity consist of a thin film of the substance of the containing sphærical envelope, moulded, so to speak, into corresponding forms. But now the diameter of the young Volvox, which is by this time sent forth on its independent career, rapidly increases, the gonidia assuming their sphærical or pyriform shape as their mutual pressure diminishes, and being hourly separated by greater intervals. If, now, the actual formative matter of the sphere receives no further or only a disproportionate increment, but is gradually attenuated by continued expansion, as a soap bubble is distended by blowing into it, the hexagonal lines into which it has been moulded by the previous mutual pressure of the embryo gonidia will be gradually stretched in all directions into finer proportions; and just as this figure is that which is *necessarily assumed* by a number of sphærical bodies under mutual pressure, *so* the most economical disposition of this particular part of the Volvox-structure will necessitate its constant attenuation into hexagons of ever-increasing delicacy. (Plate 22, Figs. 1, 3; Plate 23, Fig. 7.) If the process be continued long enough, it may finally result in the structure becoming too filmy to be detected by any microscopical observation; and it is worth noticing that it is usually in spheres of small or medium diameter that the hexagonal divisions can be developed, and not in those of the largest size. Such appears to me at present to be the rationale of the formation of this structure.

"The internal cavity of the sphere is said to be filled with a 'mucilaginous fluid.' If a Volvox be ruptured under a cover-glass, and aniline purple introduced by capillary attraction, the colour seems to be for a while repelled at that part which is in front of the rupture, and to flow round it on either side. It is only after a considerable time that it gradually penetrates this space, and brings out, by staining it of a deep purple tint, a mass of hazy matter, from which proceed streaks or lines radiating more or less regularly from its south pole. This structure, to which I do not think attention has been hitherto called, is also sometimes developed in deeply stained specimens within the slightly ruptured sphere, and seems to show that there is a denser layer of thick matter, whatever its nature may be, disposed in a somewhat regular manner, being concentrated near the south pole of the axis of rotation, whence it spreads over the inner surface in streaks resembling the lines of longitude on a terrestrial globe.

"Both from its position and from the rapidity with which it is stained by aniline purple, without which its existence is apparently absolutely undemonstrable—(in which respect it is in marked contrast to the outer cell-wall, which latter is only faintly tinted by somewhat prolonged application of the reagent, and then only where the hexagonal structure exists)—I have no doubt that this inner layer is the true 'primordia utricle' of the cell, and possesses that character of vital and formative matter which distinguishes this element of cell-structure from the outer wall, which, on the other hand, probably consists of cellulose or some similar compound. Probably the arrangement of this inner layer, in radiating lines or ribs, contributes to the elasticity of the fabric, whereby it is enabled to open at a given point for the escape of the young, and to contract again after their emission.

"The increase of individuals by the means already described is strictly an instance of subdivision.

"But *Volvox globator* also affords an instance of true alternation of generations. As may probably be affirmed of all living organisms, its life-history would be incomplete without a process of sexual reproduction, and accordingly, after a long sequence of asexual generations, a strictly sexual process intervenes, from which result certain spores destined to lie dormant for a while, and, like the zygospores of the Conjugate Algæ, to resist vicissitudes of condition and climate through the rigours of winter, and then to produce the parent form in the succeeding year, when external conditions again favour its development.

"Cohn fully traced the various stages of this process, and described them in the 'Beiträge zur Biologie der Pflanzen' (1875, Vol. I., Heft. 3), and in the 'Annales des Sciences Naturelles' (4 ième Ser. Bot., Tom. V., 323); and his observations have been more or less confirmed by other investigators, especially by Carter (Ann. Nat. Hist., 3rd Ser., Vol. III., 1859, p. 1), and more recently, in 1877, by a French botanist, M. F. Henneguay.

"Cohn and Carter both hold that there are two varieties of Volvox,* one monœcious, the other diœcious, and the latter maintains that *Sphærosira Volvox* is the male form of the diœcious sub-species. Be that as it may, the reproductive process in the monœcious form is as follows:—The sexual reproductive cells, male and female, occur in spheres of unusual size in the autumn, and are few in proportion to the number of sterile cells, and the reproductive process does not occur simultaneously with, but as a climax to a long series of asexual generations. On their first appearance the gynogonidia or female cells are about three times the size of the sterile ones, of a deep green colour, and of a frothy consistency from abundance of vacuoles. They are easily distinguished from the parthenogonidia by their never subdividing. (Plate 22, Fig. 5*b*.) They next become flask-shaped, their narrow end touching the periphery of the sphere, and the broader end hanging free in the internal cavity. (Plate 22, Fig. $5b^2$.) Finally, they assume a sphærical form, and become oospheres, each enveloped in a gelatinous membrane. (Plate 22, Fig. $5b^3$, b^4.)

"The androgonidia, or male cells, at first closely resemble the parthenogonidia, but undergoing division in two instead of three directions,

* The two forms are here accepted, after Stein, as *Volvox globator* and *Volvox minor*.

develop into *plates or discs of cells, not* into spheres, and ultimately resolve themselves into bundles of naked elongated cells, in which the chlorophyll is transformed into a reddish pigment, each with a long colourless beak, with a red 'eye-spot' and two cilia. (Plate 22, Fig. $5a$, a^2.) About the same time that the oosphere is mature these antheridia begin to move from the combined action of their cilia (Plate 23, Fig. 10), and then break up into separate antherozoids, which finally become free, and move rapidly within the cavity of the sphere. (Plate 23, Fig. $5a^3$.) Assembling round the oospheres, they penetrate the envelopes of the latter (Plate 22, Fig. 4), coalesce with their contents, and the *oosphere*, thus fertilised, becomes an *oospore*, which soon develops a cell-wall covered with conical stellate projections, and a second smooth internal membrane. (Plate 23, Fig. 11.) The chlorophyll now gradually disappears, and is replaced by an orange red pigment. In this condition the oospore constitutes the *Volvox stellatus* of Ehrenberg. It is liberated by the decay of the parent-cell, and sinks to the bottom of the water to hibernate. The subsequent history of these bodies has been traced by Cienkowski, and more recently by Henneguay ("Journal de Micrographie," Vol. II., p. 485, Bull. Soc. Philomath, Paris, July, 1878).

"Cohn believed that they must be dried up before germination was possible. Henneguay has now observed that this is not so. In spring the outer case of the spore (exospore) is ruptured, and the swollen contents (endospore) project through the opening. The contents then divide gradually into two, four, eight, sixteen, or more small cells, which become bright green, each meanwhile acquiring two vibratile cilia while still contained within the inner membrane of the spore. The cells, at first in close apposition, separate further from one another by interposition of gelatinous hyaline matter, the outer membrane disappears, the cilia become active, and the young Volvox, already containing some elements larger than the others, and destined, in due course, to produce daughter-spheres, moves freely through the water. 'The spores of Volvox, therefore, germinate in water, and each of them produces a single colony by a process of segmentation identical with that which gives rise to a daughter-colony at the expense of a cell of the mother-colony.'

"The sequence of asexual generations is repeated for many months, and in the following autumn the alternation of generations is again completed by the intervention of the processes just described."

Volvox globator. *Linn. Syst. Ed.* x.

Larger cœnobia, with very numerous cells (12,000), always with daughter-cœnobia enclosed within the mother, evolved without sexuality; fructification diœcious; the male cœnobia nourishing numerous red fascicles of spermatozoa; the female cœnobia originating 20-40 sexual cells, which after fecundation are resolved into as many red globose oospores, surrounded by a hyaline stellate epispore (=*Volvox stellatus*, Ehr.).

Size. Cœnobium as much as 1 mm. diam.

Ehrb. Infus. 68, t. 4. Dujardin Zoophy. 312, iii. f. 25. Stein Infus. p. 46. Rabh. Alg. Eur. iii. 97. Pritchard Infus. 526, t. 20, f. 32-47. Busk. Trans. Micr. Soc. 1853, p. 31. Williamson Trans. Micr. Soc. 1853, p. 45. Currey Ann. Nat. Hist. 1859, p. 5. Dr. J. B. Hicks in Micro. Journ. 1861, p. 281; in

Popular Science Review, vol. v. p. 137. A. W. Wills in Midland Naturalist, Sept.-Oct., 1880. A. Bennett in Popular Sci. Rev. 1878, p. 225.

Sphærosira volvox, Ehr. Infus. (male). Pritch. Infus. p. 526. Williamson in Popular Sci. Review, vol. ix. p. 225.

Volvox stellatus, Ehr. Infus. (oospore).

In clear pools, ponds, &c.

The relationship of *Sphærosira volvox* to *Volvox globator* has not been satisfactorily determined (see Williamson), although there remains no doubt of the existence of relationship. Some regard it as the male form, but Professor Williamson considers it a peculiar condition of *Volvox*.

For details of a successful experiment in keeping *Volvox* during the winter see N. E. Brown in Gardener's Chronicle (1879 p. 599) and "Ponds and Ditches," by M. C. Cooke, p. 63.

Plate XXII. figs. 1-3. *Volvox globator*, after A. W. Wills; 4-5, after Cohn. Explanation given above.

Plate XXIII. figs. 1-5. After A. W. Wills; 6, ideal section after Williamson; 7, after Wills—also fully described above; 8-9, × 300 after Stein; 10, complete antheridium; 11, stellate resting spore or oosphere × 400 (*Volvox stellatus*); 12, spermatozoids × 600.

Plate XXIV. Male plants of Volvox, known as *Sphærosira volvox*, after Williamson. *Fig.* 1, cœnobium; 2, protoplasmic mass from the cœnobium, containing granules; 3, mass divided in two; 4, the same divided into four; 5, the same divided into sixteen; 6, further division into thirty-two, provided with movable cilia; 7, discoid family revolving within its mother-cell.

Volvox minor. *Stein Infus. p.* 47.

Cœnobia and the number of cells smaller; the number of daughter-cœnobia evolved without sexuality within the mother, 1-9; fructification sexual, monœcious; many male cells changing into bundles of spermatozoa; 5-10 female cells in the same cœnobium, after fecundation, evolved into as many oospores, surrounded by a smooth epispore (=*Volvox aureus*, Ehr.).

Size. Variable, but smaller than the preceding.

Rabh. Alg. Eur. iii. 98. Stein Infus. t.

Volvox globator, of authors, in part.

Volvox aureus, Ehrb. Inf. 71, t. 4, f. 2 (oospore).

In similar places to the preceding.

Plate XXV. *Volvox minor* × 400 after Stein. *Fig.* 1, portion of cœnobium with two young daughter families; 2, cœnobium with two young daughter families enclosed in mother-cell; 3, cœnobium with five young fertile cells; 4, cœnobium with six young fertile cells; 5, a fertile cell enclosing numerous vacuoles indicating the commencement of subdivision; 6, isolated daughter-family still enclosed in the mother-cell; 7, encysted cell—the *Volvox aureus* of Ehrenberg; 8, isolated ordinary individual enclosed in a flask-shaped cell.

GENUS 40. **EUDORINA.** *Ehrb.* (1831.)

Cœnobium oval, involved in a common tegument; cells green, globose (16-32), enclosed within a single membrane, bearing vibratile cilia, often with a red spot (eye-spot), distributed around the hyaline sphere at equal distances apart. Asexual propagation in all the cœnobia, the cells of which are divided into 16-32 parts, and soon evolved into new cœnobia. Sexual propagation in all the cœnobia, the cells being converted into motionless oospores enclosed in a narrow epispore, afterwards becoming red.

The most complete account we possess of the life-history of *Eudorina* is that by H. J. Carter (*Ann. Nat. Hist.*, Oct., 1858), of which the following is a summary:—Unable to recognise this organism in its simplest form as a solitary cell, nor any stage of segmentation prior to the third degree of duplicative subdivision into 16 cells, he commences from this period.

At this time, which we call the first stage, the *Eudorina* consists of an ovoid green body, partially divided into the number of cells just mentioned, each of which is provided with a pair of cilia, which project through a thin gelatinous envelope that surrounds the whole mass. It is now about 1-1100ths of an inch long, *i.e.*, not more than the diameter of the *Chlamydococcus* cell, and swims by means of its cilia, with the small end foremost, and with a rotatory motion on its longitudinal axis, as often from right to left as from left to right. An eye-spot is also present in each of the four anterior cells, but seldom visible in the rest at this period.

As development progresses each cell is provided with a sphærical, translucent utricle, an eye-spot midway between the cilia and the opposite end of the cell, a contractile vesicle at the base of the cilia, and the pair of cilia themselves.

During the second stage each of the cells again undergoes duplicative division, and the whole organism becoming larger, they are separated from each other, and being no longer subject to compression, become sphærical and enclosed respectively within distinct transparent capsules. The *Eudorina* is now six times as long as in the first stage, and contains 32 green cells, which are evidently situated between two large ovoid, colourless, transparent cells, one of which bounds a similarly shaped cavity in the centre of the *Eudorina*, and the other is the original cell wall, round which again is the newly secreted envelope. Thus we see that the *Eudorina* is derived from a simple (daughter) cell, and that its green cells have resulted from a duplicative subdivision of the green matter which lined the cavity of this cell. Arrived at this state, which we shall see is that of maturity, we also observe that the posterior part of the envelope becomes crenulated, apparently from flaccidity.

After this, however, it again presents another phase, which may be called the third, or last, stage of development. Here each cell again undergoes a rapid duplicative subdivision into 16 or 32 cells, which, in the group, assume a more or less oblong figure respectively, and thus the *Eudorina's* length is increased to 10 times that of its first stage. The internal structure now gradually breaks down before the external envelope, when for a short time the groups may be seen swimming about the cavity thus formed, till at last the envelope bursts and they become liberated. What becomes of them afterwards he could not state from observation, but the green cells having been greatly reduced in size by the latter subdivisions it is probable that many of the groups, if they do not form new individuals, sooner or later become disintegrated, and the *Eudorina* thus eventually perishes.

When, however, the process of impregnation takes place, the division stops at the second stage, that is when the *Eudorina* consists of 32 cells of the largest kind, each of which is about 1-1866th of an inch in diameter within its capsule, which is therefore a little larger. The process is as follows :—

At a certain period after the second stage has become fully developed the contents of the *four* anterior cells respectively present lines of duplicative subdivision, which radiate from a point in the posterior part of the cell (in the subdivision of other cells the lines of fissiparation tend towards the centre of the cell). These lines, which ultimately divide the green contents of the cell into 64 portions, where the division stops, entail a pyriform shape on the segments, from whose extremities a mass of cilia may be observed waving in the anterior part of the cell of the parent, while yet her own pair of cilia are in active motion, and her eye-spot still exists *in situ* on one side of her progeny, thus showing that the latter may be almost fully formed before the parent perishes. At length, however, this takes place, and the progeny (*Spermatozoids*) separate from each other, and finding an exit, probably by rupture, through the effete parent cell and her capsule, soon become dispersed throughout the space between the two large ovoid cells mentioned, where they thus freely come into contact with the capsules of the twenty-eight remaining, or female cells.

The form of the spermatozoid now varies at every instant from the activity of its movements, and the almost semifluid state of its plasma. Its changes, however, are confined to elongation and contraction; hence it is sometimes linear-fusiform, or lunular, at others pyriform, short, or elongate. The centre of the body is tinged green by the presence of a little chlorophyll, while the extremities are colourless, the anterior one bears a pair of cilia, and there is an eye-spot a little in front of the middle of the body, also probably a nucleus. It is about 1-2700th of an inch long and about one-fifth as broad.

Once in the space mentioned, the spermatozoids soon find their way among the female cells to the capsules, of which they apply themselves most vigorously and pertinaciously, flattening, elongating, and changing themselves into various forms as they glide over their surfaces, until they find a point of ingress, when they appear to slip in, and, coming in contact with the female cell, to sink into her substance as by amalgamation. This author explains that there was some difficulty in seeing the act of union, but of the act itself he entertained no doubts. *Eudorina* in this stage also may frequently be seen with all the four anterior cells absent, and only a few spermatozoids left, most of which are motionless and adherent to the capsules, indicating that the rest have disappeared in the way mentioned. Lastly, many *Eudorinæ* in this stage may be observed with not only the four anterior cells absent, but with hardly a spermatozoid left, indicating that the whole had passed into the female cells or had become expended in the process of impregnation.

What changes take place in the *Eudorina* after this he had not been able to discover. At the time the female cells appear to become more opaque by the incorporation of the spermatozoids, and the crenulated state of the posterior part of the envelope in this stage seems also to indicate an approach to disintegration.

While undergoing impregnation the female cells always contain from 2 to 4 nuclei, as if preparatory to the third stage of development into which they are sometimes actually seen passing, with the spermatozoids present and scattered among them; but the effect of impregnation generally seems to arrest this stage, and thus save the species from that minute division which leads to destruction.

The author cited then goes on to explain how he conceives the other stages of the *Eudorina* are passed, which he had not the opportunity of observing. The whole memoir is one of great interest, and will well repay perusal by those who are investigating this subject.

Eudorina elegans. *Ehrb. Monats. Berl.*, 1831, *p.* 78.

Cœnobia oval, cells usually 32, globose, either scattered or quaternate, eight at each pole, distributed in three parallel circles, at equal distances from each other, around the periphery of the cœnobium.

Size. Cœnobium ·04-·15 mm. long. Cells ·018-·022 mm. diam.

Rabh. Alg. Eur. iii. 99. Ehrb. Infus. 63, t. iii. Pritchard Infus. p. 520. Carter, in Ann. Nat. Hist., Oct., 1858.

Pandorina elegans, Dujard. Zoophy., p. 317.

In standing water.

Formerly found at Hackney and Hampstead, most abundant in the spring of the year, but doubtless quite extinct at both places. "Clusters are often seen," says Pritchard, "in such amazing numbers along with *Volvox* and *Chlamydomonas pulvisculus* as to render the water of a decided green colour, especially towards the edges."

Plate XXVI. fig. 1. *a*, 16-celled family; 2, sixteen-celled family dividing into a 32-celled family; 3, part of a family, showing division in pairs; 4, 32-celled family divided into daughter-families; 5, one-celled daughter-family. All after Stein. 6, colony with three spermatic cells, having burst; 7, spermatic cells × 400; 8, spermatic cell × 800; 9, spermatozoids × 800. After Carter.

Genus 41. **PANDORINA.** *Ehrb.* (1830.)

Cœnobium globose or subglobose, invested by a broad colourless hyaline tegument; cells green, granulose, globose (16, 32, or 64), included within a single rather thick membrane, bearing two vibrating cilia, with or without a red spot, aggregated in a botryoid manner.

Propagation the same as in *Eudorina*.

Henfrey's emended character of this genus was in the following terms:—"Frond a microscopic, ellipsoidal, gelatinous mass, containing, embedded near the periphery, sixteen or more biciliated, permanently active gonidia, arranged in several circles perpendicular to the long axis of the frond. The gonidia almost globose, with a short beak-like process, a red spot, and a pair of cilia which project through the substance of the frond to form locomotive organs upon its surface. Reproduction—I., by the conversion of each gonidium into a new frond within the parent mass; II., by the conversion of the gonidia into encysted resting spores, which are set free and (?) subsequently germinate to produce new fronds."—*Quart. Micro. Journ.* (1856), *p.* 49.

Pandorina morum. *Ehr. Inf. p.* 53, *t.* II. *f.* 33.

Cœnobium globose. Cells green, 16-32, arranged about the periphery. In the forms which produce the resting spores, the cells are crowded together in the centre. Resting spores after becoming encysted bright red.

SIZE. Cœnobium ·2 mm. Cells ·01-·015 mm. diam.

Rabh. Alg. Eur. iii. 99. Henfrey Micr. Trans. (1856) p. 49, t. 4. Pringsheim Monatsb. Berlin, Oct., 1869. Ann. Nat. Hist. v. (1870) p. 272. Pritchard Infus. pp. 157 and 517, t. xix. fig. 59-69. Braun Rejuv. pp. 169-209.

In standing water.

"Fronds hyaline from about 1-80″ downwards. Gonidia either 16, and then arranged in four circles of 4, or 32 and then in five circles, two at the poles of 4, and the intermediate three of 8 gonidia, which in the perfect form stand near the periphery, and wide apart. In the forms which produce the resting spores the gonidia are crowded together in the centre. The gonidia are green, but the contents of the resting spores, after they have become encysted, are converted into oily and granular matter of a bright red colour."—*Henfrey.*

Pringsheim, in his memoir "on the pairing of Zoospores,"* makes special reference to this species. He says that asexual reproduction takes place in *Pandorina,* as in other multicellular Volvocineæ, by the formation of a perfect young plant in each cell of the mother plant. By the gradual dissolution of the general envelope and of the special membrane of the mother-cells, the young plants become free, and escape. In sexual reproduction, as in the asexual, the membrane of the old plant swells, and sixteen young plants are formed. The young plants, however, are (at least in part) not neuter, but sexual, and either male or female. Whether the mother plant is monœcious or diœcious is difficult to determine, because the male and female plants are externally alike, and can hardly be distinguished with certainty during copulation. There is no striking difference in structure between the sexual and asexual plants, although, amongst the former, plants with less than sixteen cells, especially with eight cells, are oftener produced. Moreover, the dissolution of the membrane of the mother-cell proceeds more slowly than in the case of neuter plants, one result of which is that the young asexual plants vary much in the extent of their growth, and continue united in groups of different sizes for a long time after their formation, according as a greater or less number of them have happened to become free from the gelatinous mass in which they were embedded.

As the individual groups are at first motionless, and the mother plant loses its cilia during the formation of the young ones, the entire group is at first entirely quiescent. But afterwards the young sexual plants, like the neuter ones, produce upon each of their cells two cilia, which commence their motion as soon as the enveloping mucus admits of it, and thus ultimately the entire group assumes a state of active rotation. During the rotation of the groups the same process of expansion and dissolution takes place in the membrane of the sexual plants as occurred in the mother plant; but the contents of the cells of the sexual plants do not undergo division, but combine to form a single zoospore, which becomes free by the rapid dissolution of the membranes. In their general structure these zoospores differ in no way

* Monatsbericht, Roy. Acad. Sciences, Berlin, Oct., 1869. Translated in "Annals of Natural History," Vol. V. (1870), p. 272.

from other zoospores. At their colourless apex they exhibit, like other zoospores, a red body placed on one side of the apex, and two long vibrating cilia, by which they move in the manner common to zoospores. The individual zoospores exhibit no marked differences, except that they vary in size within tolerably wide limits, but not in a manner to indicate the existence of two different sorts.

Amongst the groups of isolated zoospores of different sizes some are at last seen to approach one another in pairs. They come into contact at their anterior hyaline apex, coalesce with one another, and assume a shape resembling a figure of 8. The constriction which marks their original separation disappears by degrees; and the paired zoospores form at last a single large green globe, showing at the circumference no trace of their original separation. It may be seen, however, that the globe is larger than the individual neighbouring zoospores, that it has a strikingly enlarged colourless mouth spot, with two red bodies on the right and left, and that it is furnished with four vibrating cilia originating in pairs near the two red spots. The four cilia, however, soon become motionless, and together with the red spots disappear.

This act of conjugation occupies some minutes from the first contact of the zoospores to the formation of the green globe. The latter becomes the oospore, which, after growing slightly larger, and assuming a red colour, germinates after a long period of rest, and brings forth a new *Pandorina*. There is hardly any appreciable difference, except in size, between the male and female zoospores. Most frequently a small zoospore pairs with a larger one; but two of equal size often unite. Probably both the females and the males vary much in size, the former more so than the latter.

With regard to the entire plants from which the zoospores are produced, there is little doubt that those of the largest size are females; but the sex of the smaller and middle-sized ones cannot be determined with any certainty. The germination of the oospore is like that of other *Volvocineæ*, especially resembling in its early stage the germination of the resting spores produced by the microgonidia of *Hydrodictyon utriculatum*. The oospore bursts, and produces a single large zoospore (in rare cases two or even three), which divides into sixteen cells, and becomes a young *Pandorina*.

Plate XXVII. fig. 2. *Pandorina morum*—*a*, a very small family; *b*, *c*, sixteen-celled families; *d*, eight-celled family; *e*, solitary cell; *f*, the same, further magnified, showing process of subdivision; *g*, 32-celled family; *h*, small family undergoing division; *i*, 16-celled family divided into sixteen daughter families. All after Stein × about 500.

Genus 42. **GONIUM.** *Müller.* (1873.)

Cœnobium quadrangular, tabular, angles rounded, formed from a single flat stratum of cells, girt by a broad hyaline plano-convex tegument. Cells 16 (central 4, peripherical 12), polygonal, bright green, becoming with age disordered, granulose, connected by the produced angles, chlorophyllose vesicle central, furnished with colourless contractile vacuoles, and two long exserted cilia.

Propagation by repeated division of the cytioplasm.

Gonium pectorale. *Mull. Vermium, p.* 60.

Cœnobium flattened, quadrangular, composed of 16 green cells, furnished with vibratile cilia.

SIZE. Cœnobium, from ·05 mm. Cells from ·01 × ·007 mm.

Rabh. Alg. Eur. iii. 99. Müll. Anim. Inf. t. 16, f. 9-11. Ehrb. Infus. 56, t. 3, f. 1. Dujard. Zoophy. p. 318. Focke Studien, 30, t. 4, f. 7, 8. Fresen, Abhand. der Senck, p. 191, t. 8. Cohn Nova Acta, xxiv. p. 169, t. 18, f. 9-27. Pritchard Infus. p. 518.

In stagnant water.

The fullest account of *Gonium* is that by Cohn, published many years ago, but nothing has been added to its history since. The following is a summary of his observations:—

Each family is invested with a colourless mucous sheath which is difficult to be seen without adding some colouring matter to the water, as there appears to be no tegument. Seen from above, it is a quadrilateral tablet with rounded corners, or from the side elliptical. The primordial cells are sixteen in number, four occupying the centre disposed as a square, and three on each side external to these. The central cell of the three on each side is set a little nearer towards the centre. The cells are somewhat polygonal, the four central being hexagonal, and the twelve external pentagonal. When young the angles can scarcely be distinguished. This regular polygonal form indicates that each cell is surrounded by a firm membrane, which retains them in a fixed form. The investing membrane may also be detected at the angles of the cells, from each of which it is extended in a short tubular process, which is quite colourless. These processes are joined to those of contiguous cells, so as to link them all together. These processes are not visible in immature families, being subsequently developed.

In other points the organization of the cells resembles *Chlamydomonas*. Their contents consist of protoplasm, coloured by chlorophyll, when old containing numerous corpuscles, a central darker corpuscle, and often several vacuoles. Each cell is furnished with two cilia, which proceed from the protoplasm, through perforations in the cell wall.

The movements of the cœnobium resemble those of *Stephanosphæra;* it revolves on its short axis, so that its polar aspect is that of a rotating surface, whilst its equatorial is linear.

In the development by subdivision only the cell-contents are concerned. The fission takes place by four successive stages, or generations, in each of which bisection of the cells occurs, so that ultimately each primordial cell is subdivided into sixteen portions. When the subdivision is completed by the construction of these sixteen small cells, they are seen to occupy the same position and arrangement in the mother-cell as in the parent cœnobium.

The primordial cells of the newly formed cœnobia appear unconnected with each other. The movement of the parent cœnobium continues until the last stage of fission is completed, when it ceases, and the young daughter cœnobia commence a movement within the parent cell, sometimes appearing as a disc, and at others as a line, according as the surface or the edge is turned towards the spectator.

At length the mother-cell ruptures, and the young colony escapes into the water, moves about freely, and starts on an independent existence. Supposing that a young *Gonium* after twenty-four hours is capable of development by fission, it follows that, supposing the conditions favourable, a single colony may on the second day develop 16, on the third 256, on the fourth 4,096, and at the end of the week 268,435,456 other organisms like itself.

It has been supposed that some of the cells become detached from the mature cœnobium and pass into a resting condition, but this has not been positively demonstrated, so that fissuration is the only mode of reproduction at present known.

A fuller abstract of this paper by Cohn (from "Nova Acta," Vol. XXIV., p. 169) is given in Pritchard's Infusoria (p. 153).

Plate XXVII. fig. 1. *Gonium pectorale*—*a, b, c,* families in different positions × 400; *d, e,* the same, rather more highly magnified; *f,* family before division; *g,* family of 16 cells divided into 16 daughter families; *d* to *g* after Stein.

GENUS 43. **STEPHANOSPHÆRA.** *Cohn.* (1852.)

Cœnobium throughout its whole life rotating and moving, composed of 8 green cells, bearing two vibratile cilia, disposed at equal distances around a circle, enclosed in a common colourless hyaline, globose vesicle.

Propagation, both by macrogonidia arising from the eightfold division of the green cells, bearing two cilia, with a lateral red spot, congregated in families of eight; and by microgonidia, very much smaller, produced by multiplied division, at first revolving within the common vesicle by the action of four cilia, afterwards free, escaping singly.

Stephanosphæra pluvialis. *Cohn Hedwigia* I., *p.* 11.

Cells globose, elliptic or fusiform, often at each extremity spreading out in mucous rays.

SIZE. Cœnobium ·026-·052 mm. Cells ·006-·012 mm. diam.

Rabh. Alg. Eur. iii. 100. Currey in Micr. Journ., 1858, vi. p. 131, t. 6, f. 1-27. Cohn Zeitschr. fur Wiss. Zool., 1852, iv. p. 77. Archer Micr. Journ., 1865, p. 116. Pritchard Inf. p. 529, t. 19, f. 38-58.

In hollows of rocks, and in pools after rain.

Stephanosphæra was first observed in 1850 in Germany, and since in many places, including the British Isles.

It consists of a hyaline globe, containing eight green primordial cells, arranged in a circle in its equator. The globe rotates upon an axis perpendicular to the plane in which the primordial cells are arranged, and moves actively in space by the aid of cilia, two of which proceed from each of the primordial cells, and pierce the hyaline envelope. The primordial cells divide first into two, then four, and lastly into eight portions; these portions separate from each other in a tangential direction, thus forming a disc round which a cellular membrane is developed. Two cilia are produced upon each segment, and thus eventually eight young individuals are formed, which ultimately escape by fissure of the parent globe. This process was observed to occupy about twelve hours. Cohn also observed the division of each of the eight primordial cells into a great number of microgonidia, which swarm within the globe, and escape from it. Under certain circumstances each of the eight cells secretes a cellular covering, and swims about in the interior of the globe in the form of free *Chlamydococcus*-like cells. Eventually they escape either by fissure of the globe or by its gradual dissolution, lose their cilia, form a thicker membrane, become motionless, and accumulate at the bottom of the vessel. If the vessel be permitted to become dry, and afterwards filled with water, motile *Stephanosphæra* reappear, from which it seems probable that the green globes are the resting cells.

The resting cells vary much in size, and it is supposed that they grow considerably after attaining a state of rest. The colour is deep green, sometimes yellowish or olive, and they possess a nucleus.

The dried resting spores absorb water, and their contents gradually fill up the cavity of the containing membrane, and become cloudy and granular; the border becomes yellowish, and the red colouring matter is contracted in the centre. The cells then begin to divide and pass through successive stages, as shown on the plate (Plate 28, figs. 13 to 17). The four daughter-cells begin to quiver, and endeavour to separate from each other. Two cilia are now apparent at the pointed extremity of each of the four cells (fig. 19), by the action of which the group begins to move as a whole; utlimately all trace of the enveloping membrane disappears, and one by one the daughter-cells escape and become free. At the moment of escape their diameter never exceeds ·01 mm., but they soon enlarge to a diameter of ·013 to ·015 mm.

The length of time which elapsed between the immersion of the dried resting spores and the first appearance of the motile cells varied from nine to twenty-four hours. It was observed that those resting spores which did not produce zoospores within six days never did so afterwards, although they continued to live, and seemed perfectly healthy. Zoospores produced in November did not advance beyond the first stage. Others produced in March remained only a few hours in that condition, after which time a delicate membrane was formed round the body of the primordial cell; this membrane was at first closely attached to the cell, but became gradually enlarged, by absorption of water, into a colourless enveloping vesicle, usually globular, but sometimes oval, having two openings, through which the cilia penetrate. In this condition they attain a diameter of ·017 to ·022 mm., and are not distinguishable from encysted forms of *Chlamydococcus pluvialis*. Other zoospores, produced in April, attained a larger size, and the protoplasm of the primordial cell, instead of retaining its continuous outline, became elongated here and there into simple or forked mucilaginous rays, which were either colourless or green from the prescnce of chlorophyll. These rays are probably produced by the protoplasm adhering at certain points to the surrounding membrane, and being carried outwards by its growth. The Chlamydococcus-like form only lasted a few hours; towards the evening the zoospores mostly began to divide. The rays are drawn in, the primordial cell becomes round, it then elongates, is constricted, and ultimately is divided into four quadrants. These are again bisected, and eventually eight wedge-shaped portions are formed, whose contour lines, like the spokes of a wheel, meet in the middle.

Here is to be noted a distinction between the *Stephanosphæra* and *Chlamydococcus;* for while in the latter the individual portions of a primordial cell separate entirely from each other, each developing its own enveloping membrane, and ultimately escaping as a unicellular individual, in the former the eight portions remain united as a family. The coloured contents of the individual portions become drawn back towards the periphery in centrifugal direction, a colourless plasma remaining about the central point; this disappears at first in the centre, a cavity is formed in the middle of the disc, and as this enlarges the eight portions assume the form of a wreath, consisting of eight globular or ellipsoid bodies in close contact, usually not exactly in one plane, owing to the outer membrane not having expanded in proportion to the enlargement of the plasma. The original cilia continue active, causing the motion of the whole organism, until the eight portions are completely individualized, and then their motion ceases. The separate parts of the plasma now form eight independent but closely packed membraneless primordial cells. Shortly afterwards a delicate membrane common to them all is secreted beneath the mother-cell membrane round the disc formed by the primordial cells. This membrane is at first in contact, but afterwards becomes further and further removed as it swells and tends to assume a globular form. By the motion of the cilia the mother-cell membrane is thrown off, and the young family escapes into the water. When the Chlamydococcus-like unicellular *Stephanosphæra* has commenced its division early in the evening, the division into eight is perfected during the night, and early in the morning the young family quits its cast off mother-cell membrane.

In the course of the day the individual primordial cells and their common investing membrane grow until the latter attains a diameter of ·04 to ·048 mm. During this growth the shape of the primordial cells is changed by the formation of various prolongations, but in the course of the afternoon they again become round, and during the evening division commences in them precisely similar to the process in the unicellular *Stephanosphæra*. On the following morning we find eight young families. It is calculated that in eight days, under favourable circumstances, 16,777,216 families may be formed from one resting cell of *Stephanosphæra*.

We have given but a barren outline of the history of this little plant, but for further information must refer the student to Cohn's Original Memoir in Siebold and Kolliker's Zeitschrift fur Zoologie, 1852, p. 77. Translated in the "Annals of Natural History," 2nd series, Vol. X., pp. 321 and 401. Also Cohn and Wichura's subsequent memoir "Ueber Stephanosphæra" in Nova Acta Acad. Leop. Car., 1857, part I., Vol. XXVI. Of which an abstract is given by Currey in "Quarterly Journal of Microscopical Science," Vol. VI. (1858), p. 131. Also an admirable summary by Archer in the "Quart. Journ. of Microscopical Science" for 1865, p. 117, with additional observations by himself.

Plate XXVIII. fig. 1. Polar view of family with globose primordial cells; 2, equatorial view, with fusiform primordial cells ending in mucous filaments; 3, the same, with primordial cells collected on one side; 4, commencement of formation of macrogonidia; 5, all eight primordial cells divided in fours; 6, division advancing so that each primordial cell consists of eight cuneate segments; 7, further advanced in division, movement in the mother-cell having commenced; 8, division completed, eight young individuals revolving in the mother-cell; 9, the eight original primordial cells broken up into microgonidia; 10, young *Stephanosphæra*, (figs. 1 to 10 × 300); 11, microgonidia after exit from mother-cell × 500; 12, full-grown resting cells; 13, commencement of division in resting cell; 14 to 19, successive stages in division of resting cell; 20 to 22, naked zoospores; 23, 24, encysted zoospores; 25 to 27, division of encysted zoospores; 28, young eight-celled family resulting from division of encysted zoospore; 29, 30, young families, all after Cohn × 400; 31, amæboid condition of primordial cells, after Archer.

ORDER II. *ZYGOPHYCEÆ.*

Either unicellular or multicellular Algæ, with terminal vegetation, and destitute of true ramification. Cells single, or segregate, or geminate, or united in a series. Chlorophyll-mass for the most part distributed in plates, or bands, including one or more amylaceous granules.

Multiplication by division of the cells in one direction.

Propagation by zygospores resulting from the conjugation of two cells.

Consult here Dr. A. De Bary's "Untersuchungen uber die Familie der Conjugaten." Leipzig, 1858.

FAMILY I. DESMIDIEÆ.

Unicellular Algæ. Cells for the most part compressed, single, or segregate, or geminate, or a larger number united in a band, or filament; variable in form, usually constricted in the middle, so as to constitute two symmetrical semi-cells.

This large and interesting family is designedly excluded from the present work, as it is proposed to treat them separately. As so many students confine themselves exclusively to this family, this proposal will doubtless commend itself. The excellent text book by J. Ralfs has long been the standard for English students, and would be so still but for its scarcity, and the large number of additions in the interval since its publication.

FAMILY II. ZYGNEMACEÆ.

Multicellular Algæ. Cells cylindrical, equal at both ends; fructiferous cells more or less tumid, or inflated, all closely conjoined in filamentous families, forming an articulated simple thread, with a central cytioblast involved in radiating protoplasm. Cell walls lamellose.

Chlorophyll-mass effused, or of a definite form, often forming a spiral band.

Vegetation by repeated transverse division.

Propagation by zygospores, resulting from the conjugation of two cells. Conjugation taking place in three ways, lateral, scalariform, and genuflexuous.

This family is sub-divided into three sub-families, according to the character of the reproductive process:—

I. ZYGNEMEÆ.
II. MESOCARPEÆ.
III. GONATONEMEÆ.

We append here De Bary's scheme of classification of this Order, which he terms "Conjugatæ."

"Cells of limited growth, propagated by unlimited repeated bipartition (tripartite in *Craterospermum*) in the same direction, free or connected in single rows, chlorophyll in parietal bands, axile plates, or radiating bodies, in pairs. Cell-wall cellulose or gelatinous.

"*Fructification.* By copulation a zygospore arises of a different form from its mother-cells. No asexually produced swarmspores.

"SUBDIVISIONS.

"I. *Mesocarpeæ.* Zygospore the shape of the mother-cells, not contracted, separating by three or five partitions into a central firm-walled resting-spore and two or four lateral decaying cells. (Cells cylindrical, united in threads, with axile plates of chlorophyll.)

"II. *Zygnemeæ.* Zygospore undivided and mostly contracted, passing into the resting condition, afterwards developing into a germ-cell divided into a basal cell, and a thread-cell capable of division. (Cells cylindrical, united in threads.)

"III. *Desmidieæ.* Zygospore of the form of the *Zygnemeæ*, developing into a germ-cell, or divided into 2 or 4, each of which separates into two equal daughter-cells capable of division. (Cells usually consisting of two symmetrical halves, of very various form, free or united.)"

We have adopted a similar arrangement, with the exception of the present exclusion of the *Desmidieæ*, and the addition of a small subfamily, the *Gonatonemeæ*, which dates from a period subsequent to De Bary's Memoir.

Conjugation in the present family is the union of two cells, either of separate filaments, or of the same filament, the result being the formation of a zygospore. The cells containing the male and female element cannot at present be distinguished from each other, although De Bary states that he has observed a constant difference between the fertile and sterile cells of a species of *Spirogyra.* Usually all the cells of one filament appear to be either giving or receiving cells, so that the male and female filaments would seem to be distinct, but this requires more certain confirmation, inasmuch as in such of the species of *Spirogyra* as exhibit lateral as well as scalariform conjugation, all the cells in one filament cannot be of the same kind.

"The first perceptible change in a cell about to produce a resting-spore appears to be a loosening of the primordial utricle from the outer wall, and a contraction of it upon the cell-contents, which thus are crowded together and more or less deformed. Simultaneously with this, or a little after or before it, the side wall of the cell is ruptured, and a little pullulation or process is pushed out, which directly coats itself with cellulose and rapidly enlarges to a considerable diameter, at the same time growing in length until it meets a similar process pushing out from an opposing cell, or has attained as great a length as its laws of development will allow. When two processes meet they become fused together, the end walls are ruptured, and the contents of one cell passing over are received within those of the other, or else the contents of both cells meet within the connecting tube, and there fuse together. This is the more common mode of conjugation, in which two cells of distinct filaments become joined together by a connecting tube. It is evident that, if the filaments are fertile to their fullest extent, there will be as many of these connecting tubes as there are pairs of cells in the filaments, and a ladder-like body will be formed, the original filaments corresponding to the side pieces, the connecting tubes to the rounds. Hence this method of conjugation has received the name of *scalariform.*

"In the so-called *lateral conjugation*, instead of cells of different filaments joining, adjacent cells of one filament unite together to complete the process. The union of the two cells appears to take place in several ways. In accordance with one plan, connecting tubes, pushed out from near the ends of the cells, grow for a short distance nearly at right angles to the long axis of the filaments, and then bend at a right angle to themselves, so as to run parallel to the filament cells. The ends of these processes are, of course, opposed to one another, and coming in contact, fuse together so as to form a continuous tube for the passage of the endochrome. Another method by which neighbouring cells are sometimes connected is by the formation of coadjacent pouch-like enlargements of the opposing ends, and a subsequent fusion of these newly-formed enlargements by the absorption of the end wall between them."

"There is still another method of conjugation, the so-called *genuflexuous*, in which, instead of a connecting tube being formed as the medium of union, two cells of opposing filaments become sharply bent backwards, so that their central portions are strongly thrust forward as obtuse points, which, coming in contact, adhere, and allow of a passage-way between the cells being made by the absorption of their cohering walls."—*Wood's F. Water Algæ*, p. 161.

Hassall says that the conjugation in *Zygnæmaceæ* results in the production of "a dark body, of either an oval or circular form, and enveloped in membrane, which Vaucher, Decaisne, and Jenner regard as the true spores, but which Agardh declares resolve themselves after a time into zoospores, an opinion in which I concur, applying the term sporangia to them." It need scarcely be added that this view is erroneous, the resulting body germinating direct after a period of rest, and termed a zygospore.

The same author makes also another statement, rather vaguely stated, which is not confirmed by experience. "It is curious to remark that the cells in one part of the same filament will part with their contents and remain empty, while in another they will be the recipients of the contents of the cells of another filament." His remarks on agamæsporous *Conjugatæ* will be illustrated under the sub-family *Gonatonemeæ*.

Sub-Family 1. Zygnemeæ.

Cells cylindrical, united in threads. Zygospore undivided, and mostly contracted, passing into the resting condition, afterwards developing into a germ-cell, divided into a basal cell, and a thread-cell, capable of division.

As hereafter explained, this sub-family differs from the *Mesocarpeæ* chiefly in the development of the spore, which is not surrounded, or accompanied, by two to four deciduous lateral cells.

Genus 44. **ZYGNEMA.** *Kutz.* (1843.)

Cells with two axile many-rayed chlorophyll bodies standing near the central cell nucleus, each containing a starch-granule, or quite filled with dense granular contents, surrounding two starch-granules lying near the centre, (*a*) zygospore in the bladdery middle space between the ladder-like united pairing cells (*b*), copulation ladder-like, or lateral between two cells of the same thread.

In certain of the species of this genus the zygospores are produced in the conjugating canal, and in other species in one or other of the conjugating cells. This fact is taken advantage of in the following arrangement :—

A. Zygospores produced in conjugating canal.

* *Sporoderm scrobiculate.*

1. Zygnema pectinatum, *Ag.*

** *Sporoderm even.*

2. Zygnema Ralfsii, *Kutz.*
3. Zygnema parvulum, *Kutz.*

B. Zygospores produced in one or other of the conjugating cells.

* *Sporoderm punctate.*

4. Zygnema cruciatum (*Vauch.*).
5. Zygnema stellinum (*Vauch.*).
6. Zygnema Vaucherii, *Ag.*
7. Zygnema anomalum (*Hass.*).

** *Sporoderm even.*

8. Zygnema leiospermum, *De Bary.*
9. Zygnema insigne, *Kutz.*

A. *Zygospores produced in conjugating canal.*

Zygnema pectinatum. *Ag. Syst. p.* 78.

Sterile cells 1-2 times as long as broad.

Zygospore globose or broadly elliptic, dark olive, scrobiculate, formed in the canal of conjugation.

Size. Cells ·03-·035 mm. diam. (sometimes less), zygospore ·04 mm. diam.

De Bary Conj. p. 77, t. 1, f. 15; 19, t. 8, f. 13. Gray Arr. i. 1296.

Conjugata pectinata, Vauch. Conj. p. 77, t. 7, f. 4.

Conferva bipunctata, Eng. Bot. t. 1610.

Conferva decussata, Dillw. Conf. Syn. p. 5, (?)

Zygogonium pectinatum, Rabh. Alg. iii., 252. Kirsch. Alg. Schl. p. 126.

Tyndaridea conspicua, Hass. Alg. t. 39, f. 1, 2, Ann. Nat. Hist. xii., 187, t. 7, f. 17.

Tyndaridea immersa, Hass. Alg. t. 39, f. 3. Ann. Nat. Hist. xii. 188, t. 7, f. 19.

Tyndaridea decussata, Hass. Alg. t. 39, f. 6. Ann. N. Hist. xii., 188, t. 7, f. 18.

Zygogonium conspicuum, Kutz. Tab. v. t. 12, f. 2.

Zygogonium immersum, Kutz. Tab. v. t. 12, f. 5.

Zygogonium decussatum, Kutz. Tab. v. t. 11, f. 4.

Tyndaridea pectinata, Eng. Fl. v. p. 361; Eng. Bot. ii. t. 2597, Harv. Man. 142; Mack. Hib. 231.

Zygnema bipunctatum, Grev. Fl. Ed. 320; Fl. Devon. ii. 50.

In still waters.

As noted above, we include here three of Hassall's species of *Tyndaridea.* Kirschner does the same, with the addition of Kutzing's *Z ano-*

malum, which, however, is not the *Tyndaridea anomala* of Ralfs and Hassall, as will be evident hereafter. There does not seem to be even a sufficient difference to justify the maintenance of the different forms as varieties. This is the only British species, as far as at present known, with a scrobiculate zygospore, produced in the channel of conjugation. We have followed De Bary in referring this species to *Zygnema* instead of to *Zygogonium*. It is unnecessary in a work of this kind to discuss the reasons which have induced us in this, and similar cases, to adopt such a course. It may be well to caution the student at once that he will only waste time in the endeavour to determine species from the sterile threads. In the present, for instance, he would soon discover how hopeless it is to attempt to discriminate between the vegetative cells of this and some of its allies, without the knowledge also of the method in which the zygospore is formed, and its character when developed.

Plate XXIX. fig. 1. *a*, portion of sterile thread × 400; *b*, threads in conjugation × 200; *c*, zygospore × 400.

Zygnema Ralfsii. (*Kutz.*) *De Bary Conj. p.* 77.

Sterile cells $2\frac{1}{2}$ to 3 (rarely 4) times as long as broad.

Zygospore compressed ellipsoid, twice as long as broad, produced in the inflated conjunctive canal. Sporoderm even.

Size. Cells ·016-·017 × ·02 mm. Zygospore ·025 × ·015 mm.

Rabh. Alg. Eur. iii. p. 252.

Zygogonium Ralfsii, Kutz. Tab. v. t. 11, f. 2. Kirsch. Alg. Schl. p. 127.

Tyndaridea Ralfsii, Hassall Alg. p. 165, t. 39, fig. 4, 5.

Ann. Nat. Hist. xii. p. 188, t. 7, f. 20. Jenner Fl. Tunb. Wells. p. 182.

In pools and streams.

This is the only other British species of *Zygnema* in which the zygospore is produced in the channel, except the succeeding one, which is at best doubtful. It appears to be uncommon, at least in conjugation. First found by Mr. Ralfs at Penzance. It is still to be obtained in its old habitat, and it appears to have been discovered in France and Germany.

From the brief note of De Bary, he seems to recognise this as a distinct and veritable species of *Zygnema*, according to his interpretation of that genus.

Plate XXIX. fig. 2. *a*, portion of sterile thread × 400; *b*, threads in conjugation × 400.

Zygnema parvulum. (*Kutz.*)

Sterile cells 4 to 6 times as long as broad, zygospore globose, produced in the conjunctive canal.

Size. Cells ·02-·022 mm. Zygospore about equal.

Zygogonium parvulum, Kutz. Tab. v. t. 12, f. 4. Kutz. Sp. Alg. p. 447.

Zygnema ordinarium, Berk. Glean. t. 12, f. 1. Harv. Man. 144.

In standing pools.

If the *Zygnema ordinarium* of Berkeley's "Gleanings" can be referred to *Zygnema parvulum*, that is, as far as we have ascertained, the whole evidence upon which this species is inserted. The figure in the "Gleanings," as represented, in part, on our plate 29 (fig. 3c), is so manifestly insufficient, without measurements, that the species is introduced with some hesitation. The rest of our figures, and the description, are derived from Continental sources, and represent Kutzing's species.

Berkeley says of the plant he has figured :—"The filaments are quite unattached, and float in a rather dull green mass at the top of the water, which (at least in a state of fructification) is but little mucous, adhering imperfectly to paper in drying. But as the plant has only been once met with, and it is well known that other species of *Zygnema* are much less mucous in a state of fructification, it is uncertain whether this is peculiar at all to the species. Articulations 4 to 6 times as long as broad, at first filled with a yellowish green sporaceous mass, without any marked pellucid border, with a single row in the centre of from 5 to 7 larger granules. The mass at length contracts, and the row of granules is no longer visible. Short tubes are thrown out from the centre of the joints, by which the filaments are at length connected into a more or less intricate mass, and in the tubes a globular seed is formed, which swells them, and is furnished with a pellucid border. In general the sporaceous matter of only one articulation passes into the tube to form the seed ; nor in such case does the joint, of which the contents still appear unaltered, throw out another tube. Found at Glapthorn, Northamptonshire, in the spring of 1826, in watery spots of an exposed, ill-drained field."

Plate XXIX. fig. 3. *a*, portion of sterile thread × 400 ; *b*, threads in conjugation × 200 ; *c*, conjugating cells and zygospores of *Zygnema ordinarium*, after Berkeley, magnification unknown.

B. Zygospores produced in one or other of the conjugating cells.

Zygnema cruciatum. (*Vauch.*)

Sterile cells equal or twice as long as broad.

Zygospore sphærical, formed in one or other of two conjoined cells. Membrane brown and scrobiculate.

SIZE. Cells ·028 mm. broad. Zygospore ·04 mm. diam.

Cleve Mon. Zygn. p. 29, t. 9, f. 1-3. Kirsch. Alg. Schl. p. 126. Kutz. Tab. Phy. v. t. 17, f. 4.

Conjugata cruciata, Vauch. Hist. Conf. p. 76, t. 7, f. 2.

Tyndaridea cruciata, Hass. Alg. 160, t. 38, f. 1. Eng. Bot. Ed. 2, t. 2512 B. Eng. Fl. v. p. 361. Mack. Hib. 231.

Conferva bipunctata, Dillw. Conf. t. 2. Hook Fl. Scot. ii, 81.

Zygnema bipunctatum, Johnst. Fl. Berw. ii, 256. Gray Arr. i, 296.

Zygnema Dillwyni, Kutz. Tab. Phy. v. t. 17, f.

In ditches, pools, &c.

The form figured by Dillwyn is more slender than the typical form and is considered by some as a distinct variety.

There is, perhaps, some difficulty in determining the exact limits of the three species *L. cruciatum*, *L. stellinum*, and *L. Vaucherii*, unless by merging the latter two in one, and accepting *Z. cruciatum* as possessing globose zygospores, whilst the other species has oval, or somewhat elongated zygospores.

Plate XXX. fig. 1. *a*, portion of sterile thread × 400; *b*, conjugating threads with zygospores × 200 ; *c*, mature zygospore × 400.

Zygnema stellinum. (*Vauch.*) *Kutz. Tab. V. t.* 17, *f.* 2.

Sterile cells $1\frac{1}{2}$ to 3 times longer than broad.

Zygospore broadly ovoid, formed in one or other of the conjoined cells. Membrane brown, scrobiculate.

Sporiferous cells commonly longer than the zygospore.

SIZE. Cells ·022 mm. Zygospore ·04 × ·03 mm.

De Bary Conj. p. 78. Cleve Mon. Zyg. p. 28, t. 8, f. 9-11. Rabh. Alg. Eur. iii, 249.

Conjugata stellina, Vauch. Conf. p. 75, t. 7, f. 1.

Thwaitesia Duriæi, Mont. Fl. Alg. t. 15, f. 1.

Tyndaridea stellina, Jenner Fl. Tunb. Wells. p. 182.

In pools and ditches.

Kirschner unites this species and the next, for which he appears to have great justification. We scarcely see how they can be maintained as distinct if the broad view of *Zygnema Vaucherii* which we have adopted is tenable.

No definite period can be fixed for the production of the zygospores, not only in this species, but in the majority of the *Zygnemaceæ*. We have observed them in June, or earlier, some as soon as April, and as late as September. Hassall says "the species may be found in a state of conjugation during the entire of the spring, summer, and autumnal months; they are chiefly met with, however, in this state in the spring." Cleve has attached dates to the species enumerated by him, but as these do not correspond with the periods at which we have found them in this country, these dates are not quoted lest they should prove misleading rather than useful.

Plate XXX. fig. 2. *a*, portion of sterile thread × 400; *b*, conjugating threads and zygospores × 400.

Zygnema Vaucherii. *Ag. Syst. Alg. p.* 77.

Sterile cells $2\frac{1}{2}$ or 3 to 5 times as long as broad.

Zygospores subglobose or broadly elliptic, produced in one or other of the conjugating cells, which is usually more or less inflated, sporoderm delicately punctate.

SIZE. Cells ·01-·022 mm. Zygospore, according to the varieties.

Rabh. Alg. Eur. iii. 250.

Conjugata gracilis, Vauch. Conf. t. 6, f. 2.

Tyndaridea bicornis, Hass. Alg. 162, t. 38, f. 5.

Tyndaridea interposita, Hass. Ann. Nat. Hist. x. p. 43.

In ditches, ponds, &c.

var. a. **tenue.** *Rabh. Alg. Eur.* III. *p.* 250.

Sterile cells ·019-·022 mm., 1 to 3 times as long.

var. b. **subtile.** *Rabh. Alg. Eur.* III. *p.* 250.

Sterile cells ·015-·019 mm., 2 to 4 times as long.

Tyndaridea ovalis, Hass. Alg. t. 38, f. 8.

var. c. **stagnale.** *Kirsch.*

Sterile cells ·01 mm., 3 to 4 times as long.

Tyndaridea stagnalis, Hass. Alg. 162, t. 38, f. 9.

Tyndaridea stagnicola, Hass. Ann. N. Hist. x. (1842) p. 42. Jenner Fl. Tunb. Wells, p. 182.

It will be seen from the above that this is a variable species, of which two of the three varieties are British. These are by no means uncommon, often mixed with other filamentous algæ, and can scarcely be confounded with anything else, even when sterile.

Plate XXX. fig. 3. *a*, portion of sterile thread × 400; *b*, portion of fertile thread with zygospores × 400. Fig. 4, var. *subtile*. *a*, portion of sterile threads × 400; *b*, conjugating threads and zygospores × 400. Fig. 5, var. *stagnale*. *a*, portions of sterile threads × 400; *b*, fertile cells with zygospores × 400.

Zygnema anomalum. (*Hass.*)

Sterile cells equal, or nearly twice as long as broad; cytioderm thick, lamellose.

Zygospore globose, olivaceous (sporoderm distinctly punctate ?).

Size. Cells ·025 mm. diam., with mucous sheath about double; zygospore ·026 mm. diam.

Tyndaridea lutescens, Hass. Alg. t. 38, f. 4. Dickie Bot. Guide 296.

Tyndaridea cruciata, Harv. Man. p. 141.

Tyndaridea abbreviata, Hass. Ann. Nat. Hist. x. (1842) p. 43.

Tyndaridea anomala, Hass. Alg. t. 38, f. 2-3. Jenner Fl. Tunb. Wells, 182. Ralfs, Eng. Bot. Supp. t. 2899.

In boggy pools.

The British species is the *Tyndaridea anomala* of Hassall and Ralfs, and not the *Zygnema anomalum* of Continental botanists, which species has the zygospore produced in the conjugating canal. The following is the original description published by Ralfs in the supplement to "English Botany" :—

"It forms large, dark green masses in shallow pools on heaths. The filaments are stout; under the microscope each is found to be enclosed in a hyaline sheath, which extends on each side about half the breadth of the coloured portion, and is always more or less waved or scolloped. At first it is nearly even, but it gradually becomes more and more irregular, and the conjugating specimens are almost denuded. The joints of the filament are usually about equal in length and breadth, but sometimes twice as long as broad. The endochrome is blackish green, and at first quadrate, when it completely fills the joint, but its division into two portions gradually becomes apparent until two stellæ, but less distinct than those in the other species, are at last developed, when conjugation takes place in the usual manner. The spores, which are globular, are contained in the joints of one of the connected filaments. Not unfrequently the tubular processes are themselves converted into cells containing endochrome.

"In its early state this plant is so different in appearance from the other species, that at first sight its proper situation is scarcely apparent. Indeed, having sent specimens to several celebrated algologists, they hesitated to admit it into *Tyndaridea*, until Mr. Hassall, who also at first strongly doubted whether it belonged to the *Conjugatæ*, fortunately gathered fertile specimens. Such we ourselves found shortly afterwards, and we have since repeatedly met with them; the appearance of the plant in conjugation, however, is so altered that its identity can only be determined by tracing it through all its changes.

"In its usual state the sheath is very conspicuous, and the dense endochrome so fills the cells that the plant looks like a *Conferva*, the continuity being interrupted merely at the dissepiments. When about to conjugate the sheath has nearly or altogether disappeared, and the endochrome is collected into two stellæ, leaving the rest of the cell colourless."—*Ralfs*.

Hassall also found and examined the plant, and figured it with zygospores in the cells of the filaments, whereas the Continental species, since the figure by Kutzing, is always described as having the zygospore in the canal of conjugation. There cannot, therefore, be the slightest doubt that the species found by Hassall and Ralfs is quite distinct from that known to Kutzing, Rabenhorst, and De Bary. Priority certainly is in favour of Hassall's name, and it is the Continental species which must give way, and yield up a name, acquired in error, to its rightful claimant. Our figures are based on the sketches and drawings by Ralfs, with whom we have been in communication on this question. It is absurd to suppose that Ralfs and Hassall were both deceived, as well as Mr. Jenner (an admirable observer), to whom the species was undoubtedly known, and finally Mr. Salter in preparing the drawings from the specimens for the "English Botany." Unfortunately we could find no fruit in the specimens which we possess, collected by Ralfs forty years ago, nor could we obtain specimens in conjugation from Cornwall during the past spring.

Plate XXXI. fig. 1. *a*, *b*, portions of sterile threads × 400; *c*, fertile cells with zygospores × 400, after Ralfs; *d*, conjugating cells × 400.

Zygnema leiospermum. *De Bary. Rabh. Algæ Exs. No.* 638.

Sterile cells equal in length and breadth, or sometimes twice as long.

Zygospore globose or broadly oval, formed in one of two conjugating cells; membrane brown, even.

Sporiferous cells a little swollen.

Size. Cells ·022 mm. diam. Zygospore ·023-·03 mm.

De Bary Conj. p. 77, t. 1, f. 7-14. Rabh. Alg. iii. 249. Kirsch. Alg. Schl. p. 125.

In ditches filled after rain.

The two British species with the membrane of the zygospore even, in this section, are the present and the following, which will require some care in the discrimination. The inflated cells, which enclose the zygospores, in the present, is relied upon as one of the features which distinguish it from the succeeding species, as well as the larger size of the zygospores.

Plate XXXI. fig. 2. *a*, portion of fertile thread × 400; *b*, *c*, fertile cells, with zygospores, after De Bary × 400; *d*, mature zygospore × 400, after De Bary.

Zygnema insigne. *Kutz. Tab.* v. *t.* 17, *f.* 1.

Sterile cells equal, or twice as long as broad.

Copulation scalariform or lateral; zygospore globose or slightly oval; membrane brown, even.

SIZE. Cells ·026-·03 mm. diam.; zygospore about ·026 × ·032 mm., or globose about ·03 mm. diam.

De Bary Conj. p. 78, t. 8, f. 14-16. Rabh. Alg. iii. 249. Kutz. Tab. v. t. 17, f. 1. Kirsch. Alg. Schl. p. 125.

Tyndaridea insignis, Hass. Alg. p. 163, t. 38, f. 6, 7. Jenner Fl. Tunb. Wells 182.

Zygnema tenue, Rabh. Exs. No. 674.

In streams and ditches.

The cells of this species at the time of conjugation are apt to become much distorted, inflated sometimes on one side, sometimes on the other, and even to conjugate in the manner represented by De Bary, and copied on our plate.

Plate XXXI. fig. 3. *a,* sterile cells × 400; *b,* fertile cells with zygospores × 200; *c,* fertile cells, with longitudinal conjugation, × 200, after De Bary; *d,* zygospore × 400.

GENUS 45. **SPIROGYRA.** *Link.* (1820.)

Cells with one to several parietal chlorophyll bands, usually spirally winding to the right. Copulation ladder-like (*Spirogyra*) or lateral (*Rhynchonema*). Zygospores always within the wall of one of the united cells. Copulating cells similar to the sterile ones, or swollen out.

This genus, as now accepted, includes two genera as recognised by Kutzing, *Spirogyra* and *Rhynchonema.* In the former the conjugation was scalariform, and in the latter it was lateral. It is now found that in many species, probably in all, both kinds of conjugation take place, according to circumstances. The same filament, which in some portion of its length conjugates with a neighbouring filament, has also been observed conjugating laterally between two of its own cells. The genus *Rhynchonema* therefore has thus been proved to represent only one of the modes of conjugation of the same plant, which under other conditions conjugates with a neighbouring filament.

In past times too great importance was attached to the breadth and length of the cells in the sterile filaments, and also to the character of the spiral bands, features which are now known to be too variable to be relied upon, the most important and reliable characters being derived from the zygospore; hence only specimens in fructification can be accurately determined.

The most recent work on the species of Western Europe is a Monograph of *Spirogyra,* as represented in France, by Mons. Paul Petit. (Paris, 1880.) See also Professor Cleve's "Monograph of the Zygnemaceæ."

The following is a tabular arrangement of the British species :—

Sec. 1. Cells *not* replicate at the ends.

A. *Chlorophyll bands numerous (rarely two).*

* Spores ovoid or elliptic.

† Membrane smooth.

1. crassa, *Ktz.*
2. jugalis, *Dill.*
3. nitida, *Lk.*

†† Membrane punctate.

None.

** Spores orbicular.

† Membrane smooth.

4. orthospira, *Nag.*

†† Membrane punctate.

5. orbicularis, *Hass.*
6. bellis, *Hass.*

B. *Chlorophyll bands single or double (rarely ternate).*

* Spore membrane smooth.

7. porticalis, *Vauch.*

var. a. quinina.
Chlorophyll bands usually single.

var. β. decimina.
Chlorophyll bands usually binate, rarely ternate.

var. ς. rivularis, Hass.
Chlorophyll bands usually three.

** Spore membrane punctate.

None.

N.B.—*Spirogyra elongata,* Berk. Glean., p. 33, tab. 12, f. 3 (Rabh. Alg. iii. 241), would follow here but that the fruit is unknown, and hence it is uncertain.

C. *Chlorophyll bands single.*

* Spore membrane smooth.

9. condensata, *Vauch.*
9. longata, *Vauch.*
10. flavescens, *Cleve.*

** Spore membrane punctate.

(N.B.—No record of *Sp. velata* or *Sp. punctata* in Britain.)

Sec. 2. Cells replicate at the ends.

A. *Chlorophyll bands usually two or more.*

* Spore membrane smooth.

11. Sp. insignis, *Hass.*

** Spore membrane punctate.

12. Sp. calospora, *Cleve.*

B. *Chlorophyll bands single.*

* Spore membrane smooth.

13. Sp. quadrata, *Petit.*
14. Sp. Weberi, *Kutz.*
15. Sp. tenuissima, *Hass.*

** Spore membrane punctate.

None.

The English student may also consult with advantage a memoir "on the germination of the resting spores in Spirogyra," by Dr. Pringsheim, translated in the Annals of Natural History, 2nd ser., Vol. xi. (1853), p. 210. "On the Structure and Division of the Vegetable Cell," by J. M. Macfarlane, in Transactions of the Botanical Society of Edinburgh, Vol. xiv. (1881). Pringsheim's Researches on Chlorophyll, translated by Professor Bayley Balfour, in Quarterly Journal of Microscopical Science, Vol. xxii., new series (1882). Darwin "On the Action of Carbonate of Ammonia on Chlorophyll Bodies," in Journal of the Linnean Society, Vol. xix. (1882).

SECTION 1. Cells not replicate at the ends.

A. *Chlorophyll bands numerous (rarely two).*

Spirogyra crassa. *Kutz.*

Sterile cells with the extremities truncate, equal or twice as long as broad. Chlorophyll bands four or more, making $\frac{1}{2}$-$1\frac{1}{2}$ turns.

Zygospores broadly and obtusely oval, membrane even.

Sporiferous cells persistent, not swollen.

SIZE. Cells ·12-·15 mm. diam. (*Rabh.*), ·15 mm. diam. (*Petit*), zygospore ·14-·15 diam. (*Petit*), ·13 × ·12; ·14 × ·12; ·16 × ·12 mm. (*M.C.C.*).

Zygnema serratum, Hass. Alg. t. 18, f. 1.

Spirogyra crassa, Kutz. Tab. v. t. 28, f. 2; Kutz. Phy. Gen. t. 14, f. 4; Kirsch. Alg. Schl. p. 119; Petit Spirogyra p. 32, t. 12, f. 3, 4.

Spirogyra Heeriana, Kutz. Tab. v. t. 28, f. 3.

In ponds, &c. Fruiting in summer.

Hassall says of his *Z. serratum* that the "filaments are of nearly the same diameter as those of *Z. orbiculare*, but less mucous, from which species it may readily be distinguished by the fewer number and serrated appearance of the spores, the larger size of the granules, and the form of the sporangia, which in *Z. orbiculare* are nearly sphærical, and compressed, while in *Z. serratum* they are broadly ovate."

The sterile cells have a greater diameter than any other British species, whilst their length varies from about half a diameter to two diameters. The zygospore is comparatively broader than in *S. jugalis*, and slightly flattened, so that when seen in certain positions it appears to be narrower than it is, and more resembling that of *S. jugalis*.

On plate 32, figs. 1 and 2, the nucleus is represented in the centre of the cells. Pringsheim has recently remarked, as a fact hitherto unrecognised, that "the threads of the protoplasm extending outwards from the central plasma mass in each cell, do not, as was supposed, end in the general protoplasmic lining of the cell wall, but each passes directly or by its branches to the internal surface of a chlorophyll band, and there dilates in a trumpet-like manner, and grasps, as it were, an amylum body."—*Researches on Chlorophyll*, p. 81.

Plate XXXII. fig. 1. *a*, sterile cells × 200; *b*, fertile cells with zygospores × 200; *c*, fertile cells of *Rhynchonema* form with zygospore × 200; *d*, outline of zygospore × 400.

Spirogyra jugalis. (*Dill.*)

Sterile cells with the ends truncate, and commonly equal, or double the length of the diameter. Chlorophyll bands 4 to 5, making 1 to 2 turns.

Zygospore elliptical, membrane even.

Sporiferous cells not swollen.

SIZE. Sterile cells ·09-·1 mm. diam. (*Petit*), ·14 mm. diam. (*Cleve*), ·075-·1 mm. diam. (*Rabh.*), ·087-·11 mm. diam. (*Kirsch.*). Zygospores ·14 × ·1-·12 mm. (*Cleve*), ·15 × ·1 mm. (*Petit*), ·13-·14 × ·085-·09 mm. (*M.C.C.*).

Conferva jugalis, Dillw. Brit Conf. t. 5.

Spirogyra jugalis, Kutz. Tab. v. t. 27, f. 2; Petit Spirogyra p. 29, t. 11, f. 3, 4; Rabh. Alg. Eur. iii. 245.

Spirogyra setiformis, Petit Spirogyra, p. 29, t. 11, f. 1, 2 (not Kutz., nor Rabh. Alg. Eur.); Rabh. Exs. 2292; Cleve Mon. Zyg. p. 15 (partly), t. 1, f. 1-3.

In clear ponds, &c. Fruiting at Midsummer.

The British specimens which we refer to this species have the sterile cells from ·12 to ·14 mm. broad, and about two diameters long. The zygospore is from ·13 to ·14 mm. long and ·085 mm. broad. In other specimens, from the Continent, we have found the zygospores from ·11 to ·13 mm. long and ·095 mm. broad. M. Petit recognises two species, which he calls respectively *S. jugalis* and *S. setiformis*, differing so little from each other that it seems scarcely possible to distinguish them except in extreme cases. To the latter he refers *Z. interruptum* of Hassall, but, without the fruit, which Hassall never found, it is difficult to affirm what it might be. It is quite as probable that it was *S. orbicularis* as anything else.

Plate XXXII. fig. 2. *a*, sterile cells × 200; *b*, fertile cells with zygospores × 200; *c*, outline of zygospore × 400.

Spirogyra nitida. (*Dillw.*) *Link Handbk.* III., 262.

Sterile cells with the ends truncate, and usually 2 to 4 times as long as broad; chlorophyll bands about 4, making 1 to 4 turns of the spiral.

Spores elliptic ovoid (almost almond-shaped), 1½ times as long as broad, membrane even.

Sporiferous cells persistent.

Germinating plant clavate, radical cell much attenuated.

SIZE. Sterile cells ·072-·078 mm. diam. (*Petit*), ·08-·09 mm. (*Cleve*), ·06-·075 mm. (*Rabh.*), ·054-·077 mm. (*Kirsch*), ·07-·09 mm. (*M.C.C.*). Zygospore ·1 × ·072 mm. (*Cleve*), ·11-·13 × ·06-·07 mm. (*M.C.C.*).

Spirogyra princeps, Cleve Monog. Zygn. p. 16, t. 1, f. 4 to 7.

Conjugata princeps, Vauch. Conf. p. 64, t. 4, f. 1.

Zygnema nitidum, Lyngb. Tent. Hydr. t. 59, f. B. Hass. Alg. t. 22. Harv. Man. p. 143. Eng. Fl. v. 362. Eng. Bot. Ed. ii. t. 2509. Mack. Fl. Hib. 231. Hook. Fl. Scot. ii. 80. Dickie Bot. Guide 296.

Spirogyra nitida, Kutz. Tab. Phy. v. t. 27, f. 1. Kirsch. Alg. Schl. p. 123. Petit Spirogyra p. 28, t. 10, f. 6 to 10.

Conferva nitidum, Dill. Conf. t. 4, f. C. Eng. Bot. ed. i. t. 2337. Jenner Fl. Tunb. Wells 178. Gray Arr. i. 298.

Zygnema rostratum, Hass. Alg. t. 33, f. 1.

In ponds, &c.

Very little requires to be said of this species, which is the most common one with thick filaments in Britain. It is most probable that Hassall's *Zygnema rostratum* is the same, conjugating longitudinally, for he says that the filaments are somewhat larger than those of his *Zygnema nitidum*, but that he had only seen it once. The form of zygospore figured by him is that of the present speoies, and *not* of *Spirogyra bellis*, to which the *Rhynchonema rostrata* of Kutzing is referred by Cleve.

Cleve proposed to substitute the name of *Spirogyra princeps*, Vauch., for the universally known *Spirogyra nitida*, a change with which we by no means sympathise, because, after all, it is only a matter of opinion, and not of demonstration, whether this is really the *Conjugata princeps* of Vaucher, and there should be a good and substantial reasons for superseding a specific name so long recognised as *Spirogyra nitida*.

Plate XXXIII. fig. 1. *a, b*, sterile cells × 200; *c*, conjugating cells with zygospores × 200; *d*, outline of zygospore × 400.

Spirogyra orthospira. *Näg. in Kutz. Spec. p.* 441.

Sterile cells with the extremities truncate, and from 2½ to 4 to 10 times as long as broad; chlorophyll bands 3 to 4 to 5 (rarely 7), sometimes erect, sometimes forming a very lax spiral.

Spores orbicular, flattened, membrane even.

Sporiferous cells scarcely swollen, 2½ to 4 times as long as the diameter.

Size. Cells ·05-·065 mm. diam.; zygospore ·07 mm. diam., ·048 mm. thick.

Spirogyra orthospira, Archer in Quart. Journ. Micr. Sci., 1870. Petit Spirogyra p. 30, t. 10, f. 4, 5.

Spirogyra majuscula, Kutz. Tab. Phy. v. t. 26, f. 1. Rabh. Alg. iii. 244.

In pools. Fruiting in autumn.

This is a recently discovered species in the British Islands, and has hitherto only been recognised by Mr. Archer in Ireland.

Plate XXXIII. fig. 2. *a, a*, sterile cells × 200; *b*, conjugating cells with zygospores × 200; *c*, front and side views of zygospore × 400.

Spirogyra orbicularis. *Hassall Alg. t.* 19.

Sterile cells with the ends truncate, about equal in length to breadth; chlorophyll bands 5 to 7, making ½ to 1 turn.

Zygospores orbicular, flattened, membrane punctate.

Sporiferous cells not inflated.

SIZE. Cells ·11-·14 mm. diam.; zygospores ·1 mm. diam. Narrow diameter ·08 mm.

Petit Spirogyra p. 31, t. 12, f. 1, 2. Kutz. Tab. v. t. 27, f. 3. Kirsch. Alg. Schl. p. 118. Rabh. Alg. Eur. iii. 245.

Zygnema orbiculare, Hass. Alg. p. 138, t. 19. Jenner Fl. Tunb. Wells 178.

Zygnema alternatum, Hass. Alg. 139, t. 20.

Zygnema interruptum, Hass. Alg. 140, t. 21. Ann. Nat. Hist. 1843, p. 432.

Zygnema maximum, Hass. Ann. Nat. Hist. x. (1842), p. 36.

Spirogyra alternata, Kutz. Spec. 442. Rabh. Alg. iii. 248.

Spirogyra setiformis, Kutz. Tab. v. t. 28, fig. 1 (not Petit). Rabh. Alg. iii. 246. Cleve Mon. Zyg. p. 15 (in part).

In ponds, &c. Fruiting in autumn.

There is nothing inconsistent in Cleve's suggestion that Hassall's three plates 19, 20, and 21 all belong to the same species. No reliance can be placed on the width of the chlorophyll bands, nor the little difference in the breadth of the cells. Of course the disturbance in the bands of the conjugated cells is due to the conjugation. When this species is really in fruit there can be no difficulty in its determination, and, without fruit, it is folly to waste time in attempting to guess at the relationship of any species.

Hassall says that "it is found in ponds and dykes whose waters are deep and permanent, and it does not conjugate until near the end of summer." "Cells when in a state of conjugation, a little longer than broad, prior to which, however, they are frequently not half so long as broad; winding round the interior of these are about eight spiral threads, the granules in them being small."

Plate XXXIV. fig. 1. *a*, sterile cells × 200; *b*, conjugating cells with zygospores × 200; *c*, outline of zygospore × 400.

Spirogyra bellis. *Hassall.*

Sterile cells with the ends truncate, and usually 1½ times (rarely 3 times) as long as broad; chlorophyll bands 5 to 6, making ½ to 1 turn, or nearly erect.

Spores orbicular, depressed, with the membrane punctate or porose, chestnut colour.

Sporiferous cells persistent, swollen.

Germinating plant cylindrical, radical cell short and sub-cylindrical.

SIZE. Cells ·07-·08 mm.; zygospore ·07-·08 mm. diam., ·05-·06 mm. thick.

Cleve Monogr. Zygn. p. 18, t. 3, f. 2 to 5. Petit Spir. p. 31, t. 10, f. 1 to 3.

Zygnema bella, Hass. Alg. p. 142, t. 24. Ann. Nat. Hist. x. (1842), p. 37. Jenner Fl. Tunb. Wells 178.

Spirogyra subæqua, Kutz. Tab. Phy. v. t. 26, f. 2.

Rhynchonema rostratum, Kutz. Tab. Phy. v. t. 34, f. 3. (Not *Zygnema rostratum*, Hass. Alg. t. 33, f. 1.)

Zygnema neglectum, Hass. Alg. t. 23, f. 1 (not Petit). Hass. Ann. Nat. Hist. x. 37. Jenner Fl. Tunb. Wells 178.

In ponds. Fruiting in August.

This species is rather a characteristic one, of which it appears to us that *Zygnema neglectum*, Hass., is only a form with three chlorophyll bands. If the two species of Hassall are drawn to the same scale, it is difficult to indicate any specific difference. The *Rhynchonema rostratum* of Kutzing is referred by Cleve to this species, but the *Zygnema rostratum* of Hassall appears to be different, with thicker filaments and much longer zygospores, and is rather referable to *Spirogyra nitida*. The *Spirogyra neglecta* of Petit cannot be the *Zygnema neglectum* of Hassall.

This species is thus described by Hassall:—" Filaments about a foot in length, with truncate extremities; of considerable though rather less diameter than those of *S. nitida*, mucous, glossy, and of a deep and beautiful green colour; investing membrane of the cells very evident and transparent. Cells in the young filaments scarcely so long as broad, but their length exceeds their breadth in those which have conjugated; round the interior of the cells five or six loose spiral tubes may be faintly discerned; these contain the reproductive globules (*sic*), which are large and distinct, with a dark central nucleus. Sporangia oval sometimes almost circular and flattened, lying in inflated cells, the cavity of which they do not fill."

Plate XXXIV. fig. 2. *a*, sterile cells × 200; *b*, conjugating cells with zygospores × 200; *c*, fertile cells of *Rhynchonema* form with zygospore × 200; *d*, outline of zygospore × 400.

B. *Chlorophyll bands single or double (rarely ternate).*

Spirogyra porticalis. *Vauch.*

Sterile cells with the extremities truncate, 2 to 4 times longer than the diameter; chlorophyll bands single, or binate, rarely ternate.

Spores obtuse, ovoid, $1\frac{1}{2}$ times longer than the diameter, membrane even, chestnut colour.

Sporiferous cells equal to the length of the spore, or twice as long, more or less turgid.

SIZE. Cells ·032-·05 mm. diam. Zygospore ·08 × ·048-·05 mm.

Cleve Monog. Zygn. p. 22, t. 5, f. 8 to 13.

Conjugata porticalis, Vauch. Conf. p. 66, t. 5, f. 1.

In ditches, &c. Fruiting in spring.

var. a. **quinina.**

Chlorophyll bands usually single.

SIZE. Cells ·035-·045 mm., about twice as long.

Zygnema quininum, Hass. Alg. t. 28, f. 1, 2. Harv. Man. p. 143. Landsborough Brit. Seaweeds p. 362. Eng. Fl. v. 362. Eng. Bot. Ed. ii. p. 175. Harv. Man. 143. Johnst. Fl. Berw. ii. 256. Grev. Fl. Ed. 320. Mac. Fl. Hib. 231. Fl. Devon ii. 50. Hook. Fl. Scot. ii. 80. Dickie Bot. Guide, 296.

Spirogyra quinina, Kutz. Tab. v. t. 22, f. 2.
Spirogyra porticalis, Petit Spirogyra, p. 21, t. 5, f. 8-12.
Conferva spiralis, Dillw. Conf. t. 3. Eng. Bot. Ed. i. t. 1656.
Zygnema spiralis, Eng. Bot. Ed. ii. t. 2561.
Conjugata quinina, Gray Arr. i. 297.

var. β. **decimina.**

Chlorophyll bands usually 2, sometimes 3.

SIZE. Cells ·034-·04 mm., 2 to 4 times as long.

Zygnema deciminum, Hass. Alg. t. 23, f. 3, 4. Harv. Man. p. 143. Johnst. Fl. Berw. ii. 255. Mack. Fl. Hib. 2, 31. Fl. Devon ii. 50. Jenner Fl. Tunb. Wells 178. Grev. Fl. Edin. 320. Eng. Fl. v. 362.

Spirogyra decimina, Kutz. tab. v. t. 23, f. 3, 24, f. 1. Petit Spirogyra p. 25, t. 8, f. 1-3. Rabh. Alg. iii. p. 242.

Spirogyra flavicans, Kutz. tab. v. t. 23, f. 3.
Spirogyra laxa, Kutz. Tab. v. t. 23, f. 3.
Spirogyra major, Kutz. Tab. v. t. 24, f. 2.
Conferva jugalis, Dillw. Conf. t. 5.
Conferva inflata, Eng. Bot. Ed. i. t. 2376.

Zygnema inflatum, Eng. Bot. Ed. ii. t. 2510. Hook. Fl. Scot. ii. 80.

Conjugata inflata, Gray Arr. i. 297. (?)
Conjugata decimina, Gray Arr. i. 299.

var. c. **rivularis.** *Hass.*

SIZE. Cells ·032-·036 mm., 5 to 10 times as long.

Zygnema rivulare, Hass. Alg. 144, t. 27, f. 1, 2. Annals Nat. Hist. x. 38.

Spirogyra rivularis, Rabh. Alg. Eur. iii. 243.

Undoubtedly if the sterile threads of this species are carefully examined, they will furnish abundant evidence that the number of spiral bands is variable, for cells will constantly be found in the same filament in which either one or two bands occur. So that, with the great similarity in fruit, it would be folly to think of maintaining the two varieties *decimina* and *quinina* as distinct species, on account of the number of chlorophyll bands. The *Z. rivulare* of Hassall, which we have included as a third variety, is not uncommonly found in a sterile condition, in so far as it can be determined in this stage, but hitherto we have not seen it in fruit. It is said to be found on the Continent in fructification, but we have no knowledge of the Continental form. The spirals in the sterile cells are usually three, and then very nearly identical with the condition of the variety *decimina*, in which the bands are the same in number.

Plate XXXV. fig. 1, form *quinina*. *a*, sterile cells × 200; *b*, *c*, conjugating cells with zygospores × 200; *d*, outline zygospores × 400. Fig. 2, form *decimina*. *a*, sterile cells × 200; *b*, conjugating cells with zygospores × 200; *d*, outline zygospore × 400. Fig. 3, form *rivularis*. *a*, sterile cells × 200.

C. *Chlorophyll bands single.*

Spirogyra condensata. *Vauch.*

Sterile cells with the extremities truncate, and commonly 1 to 3½ longer than the diameter. Chlorophyll bands single, rarely two, making 1½ to 2 turns of the spiral.

Spores broadly obtuse, ovoid, or subspherical, membrane even, chestnut colour.

Sporiferous cells turgid, and usually shorter than the spores.

SIZE. Cells ·04 mm. diam., zygospores ·035-·04 mm. diam.

Cleve Monog. Zygn. p. 21, t. v. f. 1-7.

Conjugata condensata, Vauch. Conf. t. 5, f. 2. Gray Arr. i. 298.

Zygnema varians, Hass. Alg. t. 29, f. 3 and 4. Jenner Fl. Tunb. Wells, 180.

Zygnema Woodsii, Hass. Alg. t. 33, f. 2. Jenner Fl. Tunb. Wells, 180.

Spirogyra torulosa, Kutz. Tab. v. t. 20, f. 2.

Spirogyra nodosa, Kutz. Tab. v. t. 20, f. 3.

Spirogyra arcta, Kutz. Tab. v. t. 21, f. 2.

Spirogyra condensata, Kutz. Tab. v. t. 22, f. 3. Petit Spirogyra, p. 22, t. 9, fig. 6-8.

Rhynchonema Woodsii, Kutz. Tab. v. t. 34, f. 2 (not of Nord. and Wittr. Exs., No. 789).

Spirogyra Flechsigii, Rabh. Hedw. i. p. 46.

Zygnema quininum, var. Hass. Ann. Nat. Hist. x. (1842) 35.

Spirogyra ulotrichoides, Kutz. Tab. v. t. 21, f. 3.

Spirogyra varians, Kutz. Sp. Alg. p. 439. Petit Spirogyra p. 49, t. 4, f. 1-8.

Spirogyra inflata, Kutz. Tab. v. t. 21, f. 1-8.

In pools. Fruiting in spring.

From the number of synonyms quoted above, it may be inferred that this is a variable species. All the forms seem to be included by Petit under his *Spirogyra condensata* and *S. varians*.

Hassall thus alludes to a peculiar nodoluse growth of some of the forms:—"When a number of cells unite in regular order with those of a neighbouring filament, no inflation of any of these occurs; but it frequently happens that several adjoining cells of a filament for some reason or other do not unite, although the remaining ones in that filament do, in which case those which have not yoked themselves swell up, assuming a monoliform appearance, and at the same time frequently emit blind and irregular processes or prolongations, by which the cells manifest the strong tendency which they have to conjoin themselves, but which some cause, not evident, would appear to have frustrated. In some specimens the number of inflated cells and blind processes is but small, while in others the elongated cells are more numerous than those which have united in the ordinary manner." A similar circumstance may sometimes be observed in *S. longata*, especially in the short-celled forms.

Plate XXXVI. fig. 1. *a*, sterile cells × 200; *b*, conjugating cells with zygospores × 200; *c*, sterile cells of inflated form × 200; *d*, conjugating cells with zygospores × 200; *e*, *f*, *g*, outlines of zygospores × 400.

Spirogyra longata. *Vauch.*

Sterile cells with the ends truncate, 3 to 8 times as long as broad, chlorophyll bands single or rarely two, making $1\frac{1}{2}$ to 6 turns of a spiral.

Spores $1\frac{1}{2}$ to 2 times as long as broad, membrane even, chestnut colour.

Sporiferous cells swollen and usually longer than the spore.

SIZE. Cells ·024-·03 mm. diam. Zygospore ·04-·07 × ·03 mm.

Cleve Monog. Zygn. p. 20, t. 3, f. 8-10; t. 4, f. 1-7; t. 10, f. 11-13.

Conjugata longata, Vauch. Conf. p. 71, t. 6, f. 1.

In pools and ditches.

var. α. **communis.**

Sterile cells 3 to 8 times as long as broad.

Spirogyra longata, Kutz. Tab. v. t. 20, f. 1. Rabh. iii. 238. Petit Spirogyra t. 5, f. 4, 5.

Zygnema commune, Hass. Alg. t. 28, f. 5, 6. Ann. Nat. Hist. x. (1842) p. 39. Jenner Fl. Tunb. Wells, 180.

Zygnema æstivum, Hass. Alg. t. 28, f. 3, 4. Ann. Nat. Hist. xi. (1843), p. 433. Jenner Fl. Tunb. Wells, 180.

Zygnema angulare, Hass. Alg. t. 34, f. 1, 2. Jenner Fl. Tunb. Wells, 180.

Zygnema angulatum, Hass. Ann. Nat. Hist. x. (1842) p. 41.

Zygnema reversum, Hass. Alg. t. 33, f. 3.

Zygnema alternatum, Hass. Alg. p. 154.

Zygnema mirabile, Hass. Alg. t. 35, f. 1-3.

Spirogyra communis, Kutz. Tab. v. t. 19, f. 4. Petit Spirogyra t. v. f. 1-3.

Rhynchonema angulare, Kutz. Tab. v. t. 34, f. 1. Rabh. iii. 232.

Rhynchonema reversum, Kutz. Rabh. iii. 232.

Spirogyra subtilis, Kutz. Tab. v. t. 19, f. 5.

Spirogyra mirabilis, Kutz Sp. p. 438. Petit Spirogyra p. 14, t. 3, f. 3-4.

Conjugata longata, Gray Arr. i. 279 (?)

var. β. **turpis.**

Sterile cells abbreviated.

Zygnema malformatum, Hass. Alg. t. 30, f. 1, 2. Ann. Nat. Hist. x. (1842) p. 39. Jenner Fl. Tunb. Wells, 180.

Zygnema catæneforme, Hass. Alg. t. 30, f. 3, 4. Ann. Nat. Hist. x. (1842), p. 39.

Zygnema abbreviatum, Hass. Alg. t. 34, f. 4.

Spirogyra turpis, Kutz. Tab. v. t. 19, f. 2. Rab. iii. 238.

Spirogyra catœneformis, Kutz. Tab. v. t. 19, f. 1. Rab. iii. 238. Petit Spirogyra t. 3, f. 9-12.

Rhynchonema abbreviatum, Kutz. Rab. iii. 248.

We venture to differ from our friend Mons. Petit in uniting four of his species. In fact, if four species are to be accepted, we see no logical grounds for refusing to accept a dozen, because of the excessive variability in the sterile cells.

Plate XXXVI. fig. 2. *a*, *b*, sterile cells × 200; *c*, conjugating cells with zygospores × 200; *d*, fertile cells of *Rhynchonema* form with zygospore × 200; *e*, fertile cells of *mirabilis* form with zygospores × 200; *f*, conjugating cells of *catenœformis* form with zygospores × 200; *g*, *h*, *i*, *k*, outline zygospores × 400.

Spirogyra flavescens. (*Hass.*) *Cleve.*

Sterile cells with the ends truncate, 2½ to 5 times longer than broad, chlorophyll bands single.

Spores attenuated, twice as long as broad, membrane even, chestnut colour.

Sporiferous cells swollen, and usually longer than the spores.

SIZE. Cells ·02 mm. diam. Zygospore ·05 × ·024 mm.

Cleve Monog. Zygn. p. 19, t. 3, f. 6, 7.

Boggy pools on heaths, &c.

form a. **gracilis.**

Zygospore about ·03 mm. diam.

Zygnema gracile, Hass. Alg. t. 30, f. 5, 6.

Spirogyra gracilis, Kutz. Tab. v. t. 18, f. 5. Petit Spirogyra p. 15, t. 3, f. 7, 8.

Zygnema malleolum, Hass. Alg. t. 34, f. 5.

Rhynchonema malleolus, Kutz. Tab. v. t. 33, f. 3.

form b. **flavescens.**

Zygospore about ·02 mm. diam.

Zygnema flavescens, Hass. Alg. t. 30, f. 9, 10. Jenner Fl. Tunb. Wells, 180.

Spirogyra flavescens, Kutz. Tab. v. t. 18, f. 4. Petit Spirogyra p. 15, t. 3, f. 5, 6.

Zygnema affine, Hass. Alg. t. 34, f. 6.

Spirogyra affinis, Petit Spirogyra, p. 18, t. 3, f. 12, 13.

Rhynchonema affine, Kutz. Tab. v. t. 33, f. 2.

form c. **parva.**

Zygospore about ·01 mm. diam.

Zygnema parvum, Hass. Alg. t. 30, f, 7, 8. Ann. Nat. Hist. x. (1842) p. 41. Jenner Fl. Tunb. Wells, 180.

Spirogyra parva, Kutz. Tab. v. t. 18, f. 3.

This species includes five of Hassall's species of *Zygnema*, which subsequently were relegated by Kutzing, three to *Spirogyra* and two to *Rhynchonema*. The *Zygnema flavescens*, *parvum*, and *gracile*, are separated by distinctions so minute and variable, that they cannot be maintained as other than varieties, and *Zygnema malleolum* and *Z. affine* were at the time suspected of being varieties the one of the other.

Plate XXXVII. fig. 1. Variety *gracilis*. *a*, sterile cells × 200; *b*, conjugating cells with zygospores × 200; *c*, fertile cells of *Rhynchonema* form with zygospores × 200; *d*, outline zygospores × 400. Fig. 2, variety *flavescens*. *a*, sterile cells × 200; *b*, *c*, conjugating cells with zygospores × 200; *d*, fertile cells of *Rhynchonema* form with zygospores × 200; *e*, outline zygospores × 400. Fig. 3, variety *parva*. *a*, sterile cells × 200; *b*, conjugating cells with zygospores × 200; *c*, outline zygospores × 400.

Section 2. Cells replicate at the ends.

A. *Chlorophyll bands usually two or more.*

Spirogyra insignis. *Hass.*

Sterile cells with the extremities replicate, 4½ to 5 (rarely 6) times as long as broad, chlorophyll bands 2 to 3, lax, with 1 to 2 turns of spiral, or nearly erect.

Spores ovate-elliptic, twice as long as broad, membrane even.

Sporiferous cells slightly swollen.

Size. Sterile cells ·03–·035 mm. Zygospore ·04–·05 mm., 2 to 3 times as long.

Rabh. Alg. Eur. iii. 243.

Zygnema insigne, Hass. Alg. 440, t. 103, f. 1, 2.

Zygnema Hassallii, Hass. Alg. 157, t. 36, f. 4, 5. Jenner Fl. Tunb. Wells, 182.

Spirogyra insignis, Kutz. Tab. v. t. 31, f. 4. Sur. Obs. t. 1, f. a.

Rhynchonema Hassallii, Kutz. Tab. v. t. 32, f. 7.

Spirogyra Braunii, Rabh. Alg. Ex. No. 1310, 1395.

Spirogyra Hantschii, Rabh. Alg. Ex. No. 1291.

Spirogyra Theobaldii, Kutz. Tab. v. t. 31, f. 2.

Spirogyra Hassallii, Petit Bull. Soc. Bot. Fr.; Spirogyra t. 2, f. 6–8.

Rhynchonema gallicum, Ripart. in Petit Spirogyra.

In streams.

The number of British species in which the cells have replicate ends is much less than of those with truncate ends. We have only included two species with two or more chlorophyll bands, in one of which the membrane of the zygospore is smooth, and in the other punctate. Doubtless neither of them are common.

Plate XXXVIII. fig. 1. *a*, *d*, sterile cells × 200; *b*, conjugating cells with zygospores × 200; *c*, fertile cells of *Rhynchonema* form × 200; outline zygospore × 400.

Spirogyra calospora. *Cleve Mon. Zyg. p.* 26, *t.* 8, *f.* 1-5.

Sterile cells with the extremities replicate, 6 to 12 times as long as broad, chlorophyll bands 1 to 3, making 2½ to 7 turns.

Spores elongate, obtuse ovoid, 1½ to 2 times as long as broad, membrane yellow, scrobiculate.

Sporiferous cells scarcely turgid.

form a **major.**

Diameter of threads ·05 mm. Bands 2 to 3.

form β **minor.**

Diameter of threads ·032 mm. Band single.

SIZE. Zygospore ·078-·096 × ·045 mm.

Archer in Quart. Journ. Micr. Sci., 1873, xiii. p. 436. Petit Spirogyra p. 11, t. 2, fig. 11-13.

Spirogyra protecta, Wood. F. W. Alg. t. 14, f. 3.

In bogs and moor pools.

Plate XXXVIII. fig. 2. *a*, sterile cells × 200; *b*, *c*, conjugating cells with zygospores × 200; *d*, outline zygospore × 400.

B. *Chlorophyll bands single.*

Spirogyra quadrata. (*Hass.*) *Petit.*

Sterile cells 3 to 9 times as long as broad. Fertile cells turgid, quadrate. Zygospore elliptical. Sporoderm brown.

SIZE. Cells ·024 to ·027 mm. Zygospore ·042-·048 mm. diam., 1½ to 2 times as long.

Petit Spirogyra p. 8, t. 1, fig. 13. Bull. Soc. Bot. France xxi. p. 14, t. 1, fig. 2.

Zygnema quadratum, Hass. Alg. 157, t. 37, f. 1, 2. Jenner Fl. Tunb. Wells, 182.

Rhynchonema quadrata, Kutz. Tab. Phy. v. t. 32, f. 6.

In pools.

We have accepted Petit's diagnosis of this species, which Hassall had seen only with the *Rhynchonema* mode of conjugation, but which has now been ascertained to conjugate in both ways. His description is very short for a species which he says is "by no means uncommon," and he evidently depends as a specific feature on the quadrangular enlargements of the fertile cells. "Cells usually seven or eight times as long as broad. Sporangia oval, large, and much elongated, contained within quadrangular enlargements of the cells."

Plate XXXIX. fig. 1. *a*, fertile cells in conjugation with zygospore × 200, after Petit; *b*, zygospore in cell × 400.

Spirogyra Weberi. *Kutz.*

Sterile cells with the extremities replicate, 7 to 12 times as long as the diameter, chlorophyll bands single, 3 to 8 turns of the spiral.

Spores ovoid, scarce broader than the sterile threads, membrane even, chestnut, twice as long as broad.

Sporiferous cells scarcely turgid.

SIZE. Spores: (*a*) ·072 × ·034 mm. (*β*) ·068 × ·034 mm.

Cleve Monog. Zygn. p. 25, t. vii., f. 1-10.

form a. **inæqualis.**

Diameter of thread ·03 mm. Sporiferous cells scarcely longer than the spores.

Zygnema inæquale, Hass. Alg. 150, t. 32, f. 1 to 2.

Zygnema intermedium, Hass. Alg. t. 37, f. 3. Ann. Nat. Hist. x. (1842) p. 41. Jenner Fl. Tunb. Wells, 182.

Spirogyra inæqualis, Kutz. Tab. v. t. 30, f. 3.
Zygnema Grevilleanum, Hass. Alg. 149, t. 31, f. 1, 2. Hass. Ann. Nat. Hist. x. 38. Jenner Fl. Tunb. Wells, 180.

form b. **subventricosum.**

Sporiferous cells 2 to 4 longer than the spores. Diam. ·026 mm.
Spirogyra Weberi, Rabh. Alg. Eur. iii. 233.
Zygnema sub-ventricosum, Hass. Alg. 150, t. 32, f. 4, 5. Jenner Fl. Tunb. Wells, 180.
Zygnema diductum, Hass. Alg. t. 37, f. 4.
Rhynchonema diductum, Kutz. Tab. v. t. 32, f. 3.
Spirogyra ventricosa, Kutz. Tab. v. t. 29, f. 5.
Zygnema ventricosum, Hass. Ann. Nat. Hist. x. (1842) p. 38.
Zygnema longatum, Hass. Alg. 151, t. 31, f. 3, 4.

In ditches. Fruiting in summer.

The absence of any measurements, or uniformity in magnification in the figures, renders it very difficult to determine many of Hassall's species with any certainty. From present information we are unable to recognise *Z. Grevilleanum* as a distinct species.

Plate XXXIX. fig. 2. *a*, sterile cells × 200; *b*, *c*, conjugating cells with zygospores × 200; *d*, fertile cells of *Rhynchonema* form with zygospores × 200.

Spirogyra tenuissima. *Hass.*

Sterile cells with the extremities replicate, 5 to 15 times as long as the diameter. Chlorophyll bands single, making 3 to 6 turns of the spiral.
Spores broader than the sterile cells, elongated ovoid, twice as long as the diameter, membrane even and chestnut colour.
Sporiferous cells turgid.
SIZE. Spore ·055 (α)-·058 (β) × ·024 (α)-·03 mm. (β).
Cleve Monog. Zygn. p. 24, t. 6, f. 5-7.

form a. **tenuissima.**

Sterile cells 8 to 16 times as long as broad. ·012-·015 mm. diam.
Sporiferous cells 2 to 3 times as long as the spores.
Zygnema tenuissimum, Hass. Alg. t. 32, f. 9, 10. Ann. Nat. Hist. x. (1842) p. 41. Jenner Fl. Tonb. W., 180.
Zygnema minimum, Hass. Alg. t. 37, f. 8.
Spirogyra tenuissima, Kutz. Tab. v. t. 29, f. 2. Rabh. Alg. Eur. iii. 233.
Rhynchonema minimum, Kutz. Tab. v. t. 33, f. 1.
Spirogyra Naegelii, Kutz. Tab. v. t. 29, f. 3.

form b. **inflata.**

Sterile cells 5 to 10 times as long as broad. ·017-·02 mm. diam.
Sporiferous cells scarcely longer than the spores.

Zygnema varians, Hass. Ann. Nat. Hist. xi. (1843) p. 431.
Conjugata inflata, Vauch. Conf. p. 68, t. 5, f. 3.
Zygnema inflatum, Hass. Alg. t. 32, f. 6, 7. Jenner Fl. Tunb. Wells, 180.
Zygnema Jenneri, Hass. Alg. t. 37, f. 6. Jenner Fl. Tunb. Wells, 182.
Zygnema dubium, Hass. Alg. t. 37, f. 7.
Spirogyra gastroides, Kutz. Tab. v. t. 29, f. 4.
Rhynchonema Jenneri, Kutz. Tab. v. t. 32, f. 1.
Rhynchonema dubium, Kutz. Tab. v. t. 32, f. 2.
Spirogyra inflata, Rabh. Alg. Eur. iii. 233.

In pools.

This species includes the most delicate of British species with replicate ends to the cells. In all the forms of both varieties there is an evident tendency in the fertile cells to become more or less inflated. The only difference which Hassall indicates between his *Z. inflatum* and *Z. tenuissimum* is one of size, which may be influenced by the circumstances of growth.

Plate XXXIX. fig. 3. *a*, sterile cells × 200; *b*, conjugating cells of variety *a*, with zygospores × 200; *c*, conjugating cells of variety *b*, with zygospores × 200; *d*, outline of zygospores × 400.

Genus 46. **SIROGONIUM** *Kutz.* (1843.)

Cells with parietal longitudinal chlorophyll bands. Fructifying cells diverse, arising by unequal division of the thread-cells, bending knee-like towards each other and growing together, united at the point of adnation; receiving-cells barrel-shaped; giving-cells short, cylindrical. Zygospore (elliptic) in the receiving cell-wall.

The sterile cells, with parallel chlorophyll bands, resemble those of *Spirogyra*, but differ in the genuflexnous conjugation.

Sirogonium sticticum. *Kutz.*

Sterile cells 2 to 5 times as long as broad.
Zygospore broadly elliptical, spore-coat double.
Sporiferous cells swollen, abbreviated.
Size. Cells ·04 to ·05 mm., 2 to 5 times as long. Zygospore ·042 × ·075 mm.
De Bary Conj. p. 78, t. 2, figs. 1-~~6~~9 Rabh. Alg. Eur. iii., 256.
Sirogonium breviarticulatum, Kutz. Tab. Phy. v. t. 4.
Sirogonium Braunii, Kutz. Tab. Phy. v. t. 4.
Conferva stictica, Eng. Bot. t. 2463.
Zygnema curvatum, Ag. Eng. Fl. v. 362. Harv. Man. p. 143. Eng. Bot. Ed. ii. t. 2512, f. A. Hassall Alg. 143, t. 26, f. 1, 2.
Choaspes serpentina, Gray Arr. 1, 299.

In ponds and ditches and moor pools.

"It forms large masses on the water, full of air-bubbles, being pale and yellowish above, and of a blackish green beneath. Filaments not lubricous, nearly equalling those of *Spirogyra nitida*, but with much longer articulations. When young the colour is of a dull pale green, and about three imperfectly spiral lines of shining granules are with difficulty distinguishable. Afterwards these lines become more conspicuous, the rest of the filament being now perfectly colourless, and their component granules larger, but their arrangement is still irregular. The filaments subsequently unite here and there, not by every articulation, and their connecting processes are usually nearer to one end of the vessicle than to the other. Such filaments are divaricated at the points of connection. In some of the combined articulations the contents appear unchanged, in others they form a mass of larger granules than in the lines, and some have a large oval sporidium which often swells the joint. Some traces of unchanged lines occur, now and then, in the fructifying vessicles."—*English Botany*, 2nd ed., p. 176.

Plate XL, fig. 1. *a*, sterile cells × 200; *b, c, d, e*, conjugating cells × 200; *f*, zygospore × 400. After De Bary.

GENUS 47. **ZYGOGONIUM.** *Kutz.* (1843.)

Cells cylindrical or barrel-shaped, with a compact, often many-layered glittering cell-wall. On each side near the middle an irregular chlorophyll-body, each furnished with a starch granule, both often confluent in an axile string (in the very thick-walled cells usually concealed by granules). Connection of the copulating threads ladder-like. The protuberances of the two contiguous inter-growing threads that receive the chlorophyll-contents are bounded by partitions into fructifying-cells, which then coalesce into a not-contracted zygospore.

Zygogonium ericetorum. *De Bary Conj. p.* 79.

Sterile cells, $1\frac{1}{2}$ to 2 times as long as broad.

Zygospores subglobose or oblong, sporoderm rather thick, even.

SIZE.—Cells ·013 to ·018 mm. diam. Zygospore ·013 × ·025 mm.

var. a. **terrestris.**

Zygogonium ericetorum, Kutz. Tab. v. t. 10, Dickie Bot. Guide, 296. Jenner Fl. Tunb. Wells, 184. Hass. Alg. 174, t. 41, f. 1, 2.

Zygogonium torulosum, Kutz. Tab. v. t. 14.

Conferva ericetorum, Eng. Fl. v. 350; Harv. Man. 125; Dillw. Conf. t. 1, Eng. Bot. 1st Ed., t. 1553, 2nd ed. t. 2473. Grev. Fl. Ed. 318. Grev. Crypt. Fl. t. 261 (?) Mack. Hib. 224. Fl. Devon. ii. 51. Hook. Fl. Scot. ii. 81.

Conferva alpina, Eng. Fl. v. 350. Harv. Man. 125. Grev. Sc. Crypt. Fl. t. 261, f. 2.

On heaths.

var. b, **Aquaticum.**

Zygogonium didymum, Rabh. Hedw. 1, t. 3, f. 2.

Zygogonium Agardhii, Rabh. Alg. Eur. iii., p. 253.

Conferva purpurascens, Carm. Eng. Fl. v. 350. Harv. Man. 123. Mack. Hib. 224.

In pools, bogs, &c.

This is a very polymorphous species, some of the forms being terrestrial, and always sterile, others are aquatic producing zygospores. The old name of *Zygogonium erictorum* has been retained, but undoubtedly all these various forms belong to *Zygogonium Agardhii*, Rabh. (*Zyg. didymum*, R.)

"The colour, no less than the condition of the endochrome, varies considerably in this species. In some specimens the filaments are of a bright green, in which case they have always been found immersed in water; while in others, and more frequently, they are purple, of which colour they invariably are when found spreading over swampy heaths." —*Hass.*

Plate XL. fig. 2. Terrestrial form. *a*, sterile cells × 400 *Fig.* 3. var. *aquaticum*. *a*, sterile cells × 400; *b*, *c*, conjugating cells with zygospores × 400.

Doubtful Species.

Zygogonium gracile. *Berk.*

Sterile cells about five times as long as broad, of a pale or yellowish green colour.

Zygospore unknown.

Size. Cells ·014.-·016 mm. diam.

Rabh. Alg. Eur. iii., 255.

Zygnema gracile, Berk. Glean. t. 12, f. 3,

Face of a dripping rock.

Rabenhorst includes this with uncertain species of *Zygogonium*, but it seems more probable that it is a *Zygnema*, and perhaps one of the varieties of *Z. Vaucherii*. The following is the original description:—

"Pale dirty yellowish green, mucous; threads extremely fine, articulations not at all constant in length, 4 to 8 times as long as broad, marked in the centre with two approximate roundish globules. Slender filaments occur in the same mass, with joints longer in proportion, the green mass not divided into two distinct portions. I have not seen it conjugated."—*Berkeley.*

Plate XL. fig. 4. Sterile cells × 400.

Genus 48. **MOUGEOTIA.** *De Bary.* (1858.)

Cells with axile chlorophyll-plates. Copulation ladder-like. Zygospore drawn together in the swollen, bladdery, persisting middle space.

De Bary includes this genus in *Zygnemeæ*, although Wittrock joins it with *Mesocarpus*, and it seems to us very difficult to indicate any true generic distinction apart from the dividing off from the parent cells of the empty persistent cells which remain some time attached to the zygospore; nevertheless we have not followed Wittrock in uniting *Mougeotia*, *Mesocarpus*, *Pleurospermum*, *Craterospermum*, and *Staurospermum* under the one genus, *Mougeotia*,, because we think that there are sufficient characters to warrant the retention of *Staurospermum* apart from *Mesocarpus*. If the mode of development in the following two species is accurately appreciated, this genus is more allied to *Zygogonium* than *Mesocarpus*. See Archer in Quart. Micro. Journ., 1866, p. 271.

Mougeotia glyptosperma. *De Bary Conj. p.* 78, *t.* 8, *f.* 20-25.

Sterile cells 7 to 12 times as long as broad.

Zygospores large, oval, with a thick, firm, yellow-brown epispore.

Sporiferous cells elongated.

SIZE. Cells ·01-·015 mm. 6 to 10 times as long. Zygospore ·016×·035 mm.

Rabh. Alg. Eur. iii. 255. Archer in Quart. Journ. Micr. Sci. 1866, p. 65.

As pointed out by Mr. Archer (*loc. cit.*) "this plant is not truly a *Mesocarpus*, but in its mode of conjugation more nearly approaches certain *Zygnemata*. It is no doubt related, on the one hand to *Mesocarpus* (Hass.); like it the endochrome forms a compressed longitudinal band, and like it too, the zygospore is formed half-way between the two conjugating joints. But, it is distinguished strongly by the fact that here the whole cell contents 'primordial utricles' and all, of the two conjugating joints completely coalesce, leaving the old cell-walls empty, in order to form the zygospore; whilst in *Mesocarpus* the contact of the primordial utricles of the two conjugating cells is not followed by a complete coalescence of the two into the zygospore; but by a concentration of the principal part of the green and solid contents in the connecting canal half-way between the two joints, and the shutting off thereupon of the residue of the pale granular contents remaining in each parent joint, the denser central portion becoming the spore, and that cut off on each side eventually becoming effete and lost. Hence in *Mougeotia glyptosperma* the spore is the actual result of the complete fusion of the entire cell contents of the two conjugating joints—it is the true zygospore; whilst in *Mesocarpus* the ultimate spore is a daughter-cell, as it were, of the zygospore. Therefore, on the other hand, the present plant shows an affinity to *Zygnema*; but it is, of course, completely distinct in the flattened band of endochrome, not doubly stellate, as in that genus, not to speak of the extremely different comparative length of the cells, which, within the limits of each, is constant."

Plate XLI. fig. 1. *a*, sterile cells ×400; *b*, *c*, conjugating cells with zygospores, after De Bary, ×200; *d*, zygospore, after De Bary, ×400.

Mougeotia lævis. *Archer Micr. Journ.* 1867 *t.* 8, *f.* 1-3.

Sterile cells twice as long as broad.

Zygospores broadly elliptic or oval. Epispore thick, brown.

Sporiferous cells sometimes elongated.

SIZE. Cells ·02-·25 mm. Zygospore about ·045 × ·036 mm.

Rabh. Alg. Eur. iii. 255. Archer Micr. Journ. 1866, p. 270.

Zygogonium læve, Kutz. Tab. v. t. 13.

In ditches and pools.

Mr. Archer has thus described the present plant:—"Cells short, varying from nearly quadrate to three or four times longer than broad, according to the interval of time elapsed since division; the contents bright herbaceous green, forming an axile compressed band (never separate stellate chlorophyll bodies as in *Zygnema*); the conjugation taking place by short wide processes, which, along with the shortness of the cells or joints, gives the pair of conjugating filaments somewhat the appearance of a perforated ribbon-like structure; the total cell contents of each pair of conjugating joints became massed together into an elliptic zygospore within the inflated transverse tube; the longer diameter of the zygospore placed vertically to the length of the filaments; the cavity occupied thereby not shut off by any septum from the cavities of the parent joints. It was evident that there was no septum separating the zygospore from the cavities of the parent cells, but it lay freely in the inflated transverse process, though frequently in contact with its walls about the middle."

Plate XLI. fig. 2. *a*, sterile cells × 400; *b*, fertile cells with zygospores × 200.

Sub-Family 2. MESOCARPEÆ.

Cells cylindrical, united in threads, with axile plates of chlorophyll. Zygospore the shape of the mother-cells; not contracted, separating by three to five partitions into a central firm-walled resting spore, and two or four lateral decaying cells.

The method of conjugation and spore-formation in the *Mesocarpæ* was not thoroughly understood until it was investigated and explained by De Bary ("Conjugaten," 1858), who first recommended the separation of the *Mesocarpeæ* from the *Zygnemeæ*, and their recognition as separate families. His exposition of the conjugation of the *Mesocarpeæ* is thus summarised by Wittrock* in a memoir submitted to the Swedish Academy:—"Two cells grow together in the common manner by conjugation outgrowths, and a resorption of the double septum between the two conjugating cells takes place. By this a cruciated or H-shaped double cell is formed, in which at first no other change takes place than that the canal of conjugation is somewhat widened, and that the chlorophyll-coloured part of the contents of the double cell moves into the canal of conjugation, and into the parts of the double cell nearest to the canal. This cruciated or H-shaped cell, thus formed immediately by the conjugation, De Bary regards as the zygospore of the *Mesocarpeæ*, and gives it the character of being 'not contracted' in contrast with the zygospore of *Zygnemeæ* and *Desmidieæ*. This zygospore exists, however, only for a very short time as such. The above-named moving of the chlorophyllaceous bodies (not of the whole protoplasmic mass) into the connecting canal having been accomplished, the zygospore is divided by two or four septa into three or five cells, of which one, the central one, is a hypnospore, rich in chlorophyllaceous protoplasm (and later in oil), whilst the two or four lateral cells, containing no chlorophyllaceous protoplasm, are sterile, and soon going to die. Thus the *Mesocarpeæ* have, according to De Bary, spores of two kinds, namely (1), zygospores, which are formed

* "On the Spore-formation of the Mesocarpeæ." By V. B. Wittrock. Stockholm, 1878.

simply by the growing together of the two conjugating cells, without contraction, and which do not *rest*, and (2) hypnospores (resting spores), which are formed by the partition of the zygospores, and which rest (as the name indicates) for a time before germinating. The *Zygnemeæ* and *Desmidieæ* have, on the contrary, according to De Bary, spores of only one kind, namely, typical zygospores, in the formation of which a fusion and contraction of the whole protoplasmic contents of the conjugated cells takes place, and which become hypnospores without a preceding partition."

Wittrock adds:—"To me it seems perfectly clear that De Bary is quite right in saying that the hypnospores of the *Mesocarpeæ* are not analogous to the zygospores of the *Zygnemeæ*, or in other words, that they are not zygospores at all. The hypnospores of the *Mesocarpeæ* are formed by partition, and not by an immediate fusion of the protoplasm of conjugating cells, as the case ought to be with zygospores."

He then proceeds to refer to Pringsheim's observations on this subject with commendation ("Jahrbucher" xi., 1877). "The act of conjugation may be divided into two different stages. The first, being properly speaking only introductory, consists in the two cells which participate in the conjugation growing together by conjugation outgrowths, and the septum between the cells thus growing together being resorbed. This part of the act of conjugation is what Pringsheim calls *copulation*. The second stage consists in an intimate fusion taking place of the protoplasmatic contents of the conjugating cells. This fusion is effected here in the *Mesocarpeæ* principally through the moving of the chlorophyll coloured parts of the protoplasm (the chlorophyllaceous bodies) into and to the neighbourhood of the somewhat widened conjugation canal. This second and more important stage of the fecundation Pringsheim calls *connubium*. The conjugation having taken place in this manner, its effect appears by the tripartition or quinquepartition of the cruciated or H-shaped cell formed by the copulation. Of the cells formed by this partition, the central one is fertile, the two or four lateral ones sterile. The result of the conjugation is consequently not one cell, but several cells, and not cells of one kind, but of two, namely, one propagative cell (a spore), and around it two or four cells not capable of germination. It would be difficult to find a reasonable interpretation of such a result, save the one suggested by Pringsheim, of its being a *sporocarpium*, and to me this interpretation seems not only reasonable, but perfectly natural, for although the sporocarpium does here remain on a very low, not to say the very lowest, stage of development, it does, however, already possess the constituent parts of a typical sporocarpium. It has a nucleus and a pericarpium, or at least an equivalent to one. The nucleus is the single central spore-cell, and the pericarpium is represented by the two or four lateral sterile cells."

"If the explanation given above is accepted, the essential difference between these Algæ and their nearest relations, *Zygnemeæ* and *Desmidieæ*, might be expressed in the following manner:—The result of the connubium in the former is a sporocarpium (and their spore is consequently a *carpospore*), but the result in the latter is a *zygospore*."

Wittrock then proceeds to show that in one species the formation of the spores can take place equally in the manner of *Mesocarpus*, *Plagiospermum*, and *Staurospermum*, equally by tripartition, quadripartition, and quinquepartition, and hence he concludes that those genera are not sound, and that all three should be included under sub-sections of the same genus. We have not followed this suggestion, but have retained *Mesocarpus* and *Staurospermum* as distinct, relying upon the difference of form in the central cell.

For further details we refer the student to the Memoir from whence the foregoing observations are abstracted.

Genus 49. **MESOCARPUS.** *Hass.* (1845.)

Spore sphærical or oval, between two cylindrical, straight or slightly in-bent lateral cells. (*a*) Copulation ladder-like, threads free, or with one end attached; (*b*) copulation lateral between two neighbouring cells of a thread, rarely ladder-like. Sterile cells often with a knee-like bend, and intergrown at the bend with similar cells of another thread.

Including also the genera *Pleurocarpus* and *Craterospermum* of Braun.

† Spore membrane sorobiculate or punctate.
M. nummuloides, *Hass.*
M. depressus, *Hass.*
†† Spore membrane smooth.
M. parvulus, *Hass.*
M. recurvus, *Hass.*
M. scalaris, *Hass.*
Sub-gen. *Pleurocarpus*, Braun.
M. pleurocarpus, *De Bary.*

† *Spore membrane scrobiculate or punctate.*

Mesocarpus nummuloides. (*Hass.*) *De Bary.*

Sterile cells 7-14 times as long as broad. Zygospore spherical, or broadly ovoid; membrane brown, scrobiculate.

Size. Cells ·015 mm. diam. Zygospore ·044 × ·034 mm.

De Bary Conj p. 80, t. 8, f. 9, 10. Cleve Mon. Zyg. p. 30, t. 9, f. 4, 5. Hass. Alg. 169, t. 45, f. 1. Rabh. Alg. Eur. iii. 257.

Sphærocarpus nummuloides, Hass. Ann. Nat. Hist. xii. 187, t. 7, f. 12.

In ditches. Fruiting in September.

Plate XLI. fig. 3. *a*, sterile cells × 400; *b*, fertile cells, with zygospores, × 400.

Mesocarpus depressus. *Hass.*

Sterile cells 7-12 times as long as broad. Zygospore elliptical, compressed; membrane brown, punctate.

Size. ·007-·015 mm.

Hass. Alg. 168, t. 44, f. 1. Jenner Fl. Tunb. Wells 184.

Sphærocarpus depressus, Hass. Ann. Nat. Hist. xii. 186, t. 7, f. 11.

var. B. **ovalis.** *Rabh. Alg. Eur.* III. 257.

Mesocarpus ovalis, Hass. Alg. 169, t. 44, f. 2.

Sphærocarpus ovalis, Hass. Ann. Nat. Hist. xii. 189, t. 7, f. 15.

In boggy waters.

There seems to be no specific difference between the two species of *S. depressus* and *S. ovalis* of Hassall, the only feature relied upon being that the filaments in the latter are scarcely more than half the diameter of the former.

Plate XLI. fig. 4. *a*, sterile cells × 400; *b*, fertile cells, with zygospores, × 400. *Fig.* 5, var. *ovalis*. *a*, sterile cells × 400; *b*, fertile cells, with zygospores, × 400.

†† *Spore membrane smooth.*

Mesocarpus parvulus. (*Hass.*) *De Bary.*

Sterile cells 5-12 times as long as broad. Zygospore spherical; membrane even, commonly twice the diameter of the threads.

SIZE. Cells ·01 mm. Zygospore ·02-·024 mm.

De Bary Conj. p. 80, t. 2, f. 15. Cleve Mon. Zyg. p. 31, t. 9, f. 6, 7. Hass. Alg. 169, t. 45, f. 2, 3. Jenner Fl. Tunb. Wells 184.

Sphærocarpus parvulus, Hass, Ann. Nat. Hist. xi. 434, t. 7, f. 13, 14.

Mougeotia splendens, Kutz. Tab. Phy. v. p. 1.

var B. **angustus.** *Hass.*

Mesocarpus parvulus, var. *tenuissima*, De Bary Conj. t. 11, f. 10-14.

Mesocarpus angustus, Hass. Alg. 170, t. 45, f. 4.

Sphærocarpus angustus, Hass. Ann. Nat. Hist. xii. 187, t. 7, f. 16.

Mixed with other Algæ, in ponds, &c.

Plate XLII. fig. 3. *a*, sterile cells × 400; *b, c*, fertile cells, with zygospores, × 400. *Fig.* 4, var. *angustus*. *a*, sterile cells × 400; *b*, fertile cells, with zygospores, × 400; *c*, mature zygospore × 400.

Mesocarpus scalaris. (*Hass.*) *De Bary.*

Sterile cells 2-4 times as long as broad; zygospore spherical or broadly ovoid; membrane brown, *even*, about equal in diameter to the threads.

SIZE. Cells ·034 mm. diam. Zygospore ·034 mm. diam.

De Bary Conj. p. 80. Cleve Mon. Zyg. p. 32, t. 9, f. 11, 12. Hass. Alg. 166, t. 42, f. 1. Hass. Ann. Nat. Hist. x. p. 45; xii. t. 7, f. 7. Rabh. Alg. Eur. iii. 257. Kutz. Tab. Phy. v. t. 5.

Mesocarpus intricatus, Hass. Alg. 167, t. 43, f. 1. Jenner Fl. Tunb. Wells 184.

Sphærocarpus intricatus, Hass. Ann. Nat. Hist. xii, 186, t. 7, f. 9.

In boggy pools, &c.

We can recognize no plausible gronnds on which the *M. intricatus* of Hassall can be maintained as a species distinct from *M. scalaris.*

Plate XLII. fig. 1. *a,* sterile cells × 400; *b,* conjugating cells, with zygospores × 400.

Mesocarpus recurvus. *Hass.*

Sterile cells 5 to 10 times as long as broad.
Zygospore globose. Sporoderm brown, even.
SIZE. ·012-·018 mm. Zygospore ·023 mm. diam.

Hass. Alg. 168, t. 44, f. 1. Rabh. Alg. Eur. iii. 257.
Sphæricarpus recurvus, Hass. Ann. N. Hist. xii. 186, t. 7, f. 10.

In ditches.

Plate XLII. fig. 2. *a,* sterile cells × 400; *b,* conjugating cells with zygospores × 400.

Sub-Genus PLEUROCARPUS. *Braun.*

Mesocarpus pleurocarpus. *De Bary Conj. p.* 81.

Sterile cells 2 to 3 times as long as broad.
Zygospores subglobose, brown, even.
SIZE. Cells ·025-·03 mm. Zygospore ·03 mm. diam.

Pleurocarpus mirabilis, Braun. Alg. Uni. p. 60. Rabh. Alg. iii, 258.
Zygogonium pleurospermum, Kutz Tab. v. t 13.
Mougeotia genuflexa, Ag. and others. Eng. Fl. v. 360. Eng. Bot. Ed. 11. t. 2505. Jenner. Fl. Tunb. Wells, 182. Hass. Alg. 172, t. 40, f. 2. Harv. Man. 141. Mack. Fl. Hib. 231. Dickie Bot. Guide, 296.
Conferva genuflexa, Dillw. Conf. t. 6. Eng. Bot. Ed. 1, t. 1914.
Zygnema genuflexum, Johnst. Fl. Berw. ii. 257. Grev. Fl. Ed. 320.
Serpentaria genuflexa, Gray Arr. 1, 300.

var. **compressus.**

Mougeotia compressa, Eng. Fl. v. p. 360. Eng. Bot. Ed. 2, p. 172. Harv. Man. 141.
Zygnema compressum, Lyngb. Hyd. Dan. t. 58.
Serpentaria compressa, Gray Arr. 1. 300.
Pleurocarpus compressus, Rabh. Alg. Eur. iii. 258.

In moor pools, &c.

This widely diffused species forms vast yellowish-green masses, which Harvey says are often thirty feet in diameter; we have often met with them covering several square feet. The filaments are fragile, soon breaking into short lengths, bent almost at right angles and united at the angles, hence the old name of *Mougeotia genuflexa.*

Plate XLIII. fig. 1. Cells in conjugation × 400; *b,* fertile cells with zygospore, after De Bary × 400; *c, c,* zygospores × 400.

GENUS 50. **STAUROSPERMUM.** *Kutz.* (1843.)

Spores four cornered, between the truncated corners of four sessile lateral cells (cells of all the species up to twenty times longer than broad.)

† Sporoderm porose.
S. quadratum, *Hass.*
†† Sporoderm verrucose.
S. gracillimum, *Hass.*
††† Sporoderm smooth.
S. capucinnm, *Kutz.*
S. viride, *Kutz.*

† *Sporoderm porose.*

Staurospermum quadratum. (*Hass.*) *De Bary.*

Sterile cells 10 to 20 times longer than broad.

Epispore quadrangular, with the angles truncate, not replicate, sides straight, covered with large pores (about 50 on the longer side).

SIZE. Cells ·015-·02 mm. Zygospore ·04-·044 mm.

De Bary Conj. p. 81, t. 8, f. 11. Cleve Mon. Zyg. p. 34, t. 10, f. 3. Rabh. Alg. Eur. iii. 259.

Staurocarpus quadrangulatus, Hass. Ann. Nat. Hist. xi. p. 434. Jenner. Fl. Tunb. Wells, 184.

Staurocarpus quadratus, Hass. Alg. 178, t. 48, f. 1.

Mougeotia quadrangulatus, Hass. Ann. Nat. Hist. xii. 185, t. 7, f. 3.

In ponds, ditches, &c.

Plate XLIII. fig. 2. *a*, sterile cells × 400; *b*, *b*, conjugating cells with zygospores × 400.

†† *Sporoderm verrucose.*

Staurospermum gracillimum. (*Hass.*)

Sterile cells 8 to 15 times as long as broad, pale yellowish green.

Zygospore quadrate, the sides deeply sinuate, angles retuse. Sporoderm verrucose.

SIZE. Cells ·006 ·008 mm. Zygospore ·02 mm. diam.

De Bary Conj. p. 81. Rabh. Alg. Eur. iii. 260.

Staurocarpus gracillimus, Hass. Alg. 179, t. 49, f. 2. Jenner Fl. Tunb. Wells, 184. Hass. Ann. Nat. Hist. xii. 185, t. 7, f. 6.

In bogs and moor pools.

Plate XLIII. fig. 3. *a*, sterile cells × 400; *b*, conjugating cells with zygospores × 400.

††† *Sporoderm smooth.*

Staurospermum capucinum. *Kutz.*

Sterile cells 6 to 14 times as long as broad.

Zygospore quadrate, angles obtuse or truncate, sides often deeply sinuate. Sporoderm even.

SIZE. ·015 × ·02 mm. Zygospore ·05 × ·04 mm.

De Bary Conj. p. 81. Rabh. Alg. Eur. iii. 259.

Staurocarpus glutinosus, Hass. Alg, 177, t. 47, f. 1.

Staurocarpus cærulescens, Hass. Alg. t. 47, f. 2. Jenner Fl. Tunb. Wells, 184.

Mougeotia glutinosa, Hass. Ann. Nat Hist. xxii. t. 7, f. 1.

Staurocarpus capucinus, Hass. Ann. Nat. Hist. xii. p. 184, t. 7, f. 2.

Mougeotia cærulescens, Eng. Fl. v. 360. Harv. Man. 141. Eng. Bot. Ed. 2, t. 2506.

Conferva cærulescens, Eng. Bot. t. 2457.

Agardhia cærulescens, Gray Arr. i. 299.

Leda capucino, Bory in Mong. & Nest. Ex. 793.

In ditches and ponds.

The filaments soon acquire a bluish tinge, and in drying assume a purple hue.

Plate XLIV. fig. 1. *a,* sterile cells × 400; *b,* conjugating cells with zygospores × 400.

Staurospermum viride. *Kutz.*

Sterile cells 10 to 20 times as long as broad.

Epispore quadrangular, angles truncate and replicate, sides concave, smooth.

SIZE. Cells ·008 mm. Zygospore ·025 mm.

De Bary Conj. p. 81, t. 2, f. 17-18. Cleve Mon. Zyg. p. 34, t. 10, f. 4-5. Rabh. Alg. Eur. iii. 260.

Staurocarpus gracilis, Hass. Ann. Nat. Hist. xii. 185, t. 7, f. 5. Hass. Alg. 179, t. 49, f. 1. Jenner Fl. Tunb. Wells, 184.

Staurocarpus virescens, Hass. Alg. 178, t. 48, f. 2.

Staurocarpus affinis, Hass. Ann. Nat. Hist. xii. 185, t. 7, f. 4.

Staurospermum franconicum, Reinsch. Algen. Fl. p. 217.

In ditches.

Plate XLIV. fig. 2. *a,* sterile cells × 400; *b,* conjugating cells with zygospores × 400; *c,* development of zygospores from conjugated cells × 400, after De Bary,

Sub-Family 3. GONATONEMEÆ.

Cells cylindrical, much elongated, united in threads, with axile plates of chlorophyll. Agamospores produced without conjugation in cells continuous with, and partitioned from the mother cells.

Wittrock includes his single genus *Gonatonema* in the *Mesocarpeæ* as an agamosporous form, without ascertained conjugation. As an excuse for this he says:—"If we attached importance only to the neutral or sexual nature of the spore formation, as some of the modern systematizing botanists do even in the lower *Cryptogamæ*, we should be obliged to form a separate family for it, which might not even be placed in the class of *Conjugatæ*. To me the accordance with *Mesocarpeæ* as to the vegetative cells and the formation of the spores seems too great to allow the separation of *Gonatonema* from this family. It may not be unnecessary here to call to mind that the class of *Diatomaceæ* in which the formation of spores is in general effected through conjugation, does also embrace some genera where the spores are formed neutrally."

At the risk of condemnation as a "modern systematizing botanist," we do not feel content to include this genus in the *Mesocarpeæ*, and have therefore relegated it to a separate family until more complete evidence is furnished as to whether it really should be associated with the *Conjugatæ* at all, although its affinities seem to lie in that direction. All we are justified by the facts to assume is that it is an aberrant form, which, on the faith of its vegetative character may for the present be retained in proximity to the *Mesocarpeæ* until its relationship is better established.

Genus 51. **GONATONEMA.** *Wittrock.* (1878.)

Spores (agamospores not carpospores) without conjugation, formed by biseptation of the mother cells, which latter are bent angularly, and alternately, at the point of fructification.

Wittrock illustrates this genus by means of a species not yet ascertained to be British, but which he regards as congeneric with Hassall's species hereafter described. "Its vegetative stage consists of cylindric cells arranged in a single row. The membrane of the cells is very thin, and consists of pure cellulose. The bottoms of somewhat older cells are gently curved inwards, which gives rise to a small lens-shaped room between the cells. The contents of the cells consist of (1) a parietal thin colourless layer of protoplasm; (2) an axile cholrophyll-coloured rather thick band of protoplasm (the single chlorophyllaceous body of the cell) which runs through the whole length of the cell, and which is most frequently more or less excavated at both ends of the cell; in the band of chlorophyll occur the so-called 'starch granules,' in a number of 2 to 4; (3) a rounded nucleus, which has its place at the side of the chlorophyllaceous body, or very often in a small circular opening in the middle part of the band of chlorophyll; (4) small drops of oil, attached partly to the inner side of the parietal layer of protoplasm, and partly to the outer side of the chlorophyllaceous band; and (5) colourless cell liquid, which fills the vacuoles between the parietal layer of protoplasm and the axile chlorophyllaceous band.

"In purely vegetative cells the chlorophyllaceous body is found to possess the power of making free, and rather quick movements. This species thus gives a second instance of independent movements of chlorophyllaceous bodies belonging to vegetative cells.

"The formation of vegetative cells takes place by bipartition, exactly in the same manner as in the *Mesocarpeæ*. The cells destined to bring forth spores have always a very considerable development as to length. While the vegetative cells just formed by bipartition are only 5 to 6 times as long as thick, the cells which are ready to form spores are at least 9, and more often 12 to 16 times as long as thick. A rather considerable increase as to volume, by development in length, does consequently take place in these cells before they are capable of fulfilling their propagative purpose.

"The first sign of a beginning spore-formation is that the cell widens at its middle, so that this part resembles a cask. This widening is not, however, equally powerful on all sides, but is stronger on one side than on the other sides. At the same time the cell bends at its middle like a knee, so that its two halves form a more or less obtuse angle with each other. The point of the angle is placed where the before-mentioned more powerful widening of the cell has taken place. Almost always the formation of spores takes place at the same time in all the cells of a filament. Then it regularly occurs that the cells bend alternately in opposite directions, so that if cell No. I bends to the right, cell No. 2 bends to the left, No. 3 to the right, and No. 4 to the left again, and so on. Consequently the cells in a filament-producing spores will form a zig-zag line. Exceptions from this rule do, however, now and then occur; thus, that two cells abutting on each other bend in the same direction, after which the two next bend in an opposite direction and so on. When this occurs, the filament is gently curved like an S, alternately in two directions. When the spore-forming cell widens and bends, the chlorophyllaceous band of the cell is often interrupted at its middle part, by which the cell gets two chlorophyllaceous bodies instead of one. The chlorophyll-coloured protoplasm now begins anew to give proofs of its power of free motion. The chlorophyllaceons body (or bodies if there are two) moves freely and rather quickly, from the other parts of the cell to the widened middle part. When all of it has entered this part of the cell, which has thus become almost quite filled with chlorophyll-coloured protoplasm, the cell is divided into three cells by two septa, appearing one on each side of the chlorophyll filled central part. The cells formed by this partition are of two essentially different kinds. The two lateral cells have very little living contents. All the chlorophyll-coloured protoplasm is gone, and only the thin parietal layer of protoplasm and some drops of oil are left. The rest of the contents are only colourless cell-liquid. These cells have in fact filled their purpose. They soon die, and remain, as mere skeletons of cells, attached for some time (two or three weeks) to the central cell. The central cell is, in contrast to the lateral cells, very rich in living contents, having received all of the chlorophyll-coloured protoplasm of the mother-cell. It is also designed to become the hypnospore, through which the propagation of the species is to be affected. But before it becomes a complete hypnospore it is to pass through several stages of development. The first of these is that the cell-contents surround themselves with a new layer of cellulose (mesosporium) within the original one (exosporium). The mesosporium increases by-and-bye in thickness till it is considerably thicker than both the exosporium and the endosporium (which appears later). The mesosporium gets no sculpture (as is the case with so many *Mesocarpeæ*) it remains always smooth. But having been at the beginning hyaline, it soon assumes a faint yellow colour. Within the mesosporium a new layer of cellulose forms during the first week; this is called endosporium. It remains always hyaline and very thin. During this time the contents of the cell have also suffered a change. The chlorophyll-coloured protoplasm, at least the greater part of it, has changed into a fat oil, which is coloured in the same manner as the mesosporium, *i.e.*, a faint yellow. The hypnospore which is now ready, shows a somewhat different shape, if regarded from different sides. If regarded in the position it has when the curvatures of the spore-forming filament are directed to the right and left of the observer, the spore is, as a rule, non-symmetrically elliptic, with abrupt ends, very seldom it is almost circular. The want of symmetry consists in the spore being more convex on the side towards which the knee of the mother-cell has bent. If we imagine the spore being turned a quarter of a turn round its longitudinal axis, it appears somewhat narrower, and perfectly elliptical, with abrupt ends. How the spores behave when germinating I have not yet had any opportunity of observing."

"Thus it appears from the foregoing details that the spores are always formed without a preceding act of conjugation. The spore formation, therefore, may be regarded as neutral, or we may assume that as in exceptional cases spores may be formed by the instrumentality of a single cell, in this ease the exception has become the rule, and the spores would then be regarded as parthenospores, and not as agamospores."

Under these circumstances of development, Wittrock considers himself justified in proposing the genus *Gonatonema* for the two forms, the one *Gonatonema ventricosum*, on which the above observations were made, and the other the species which Hassall described as *Mesocarpus notabilis.*

Gonatonema notabile. (*Hass.*) *Wittr.*

Sterile cells 8 to 10 times as long as broad, sometimes longer.

Zygospore, front view cylindrical, side view bent so as to be convex on one side, concave on the other, truncate at the ends, same diameter as the vegetative cells.

SIZE. Cells ·012-·015 mm.

Wittrock Mesocarpeæ, p. 16, fig. 14.
Mosocarpus notabilis, Hass. Alg. 170, t. 46, f. 2.
Mougeotia notabilis, Hass. Ann. Nat. Hist. x. p. 46.
Staurospermum notabile, Rabh. Alg. Eur. iii. 261.

Found in great abundance in some brick fields near Notting Hill.—*Hassall.*

Here follows the original description by Hassall:—"Filaments at first cylindrical, but subsequently becoming angulated, the angle of flexion being situate in the centre of each cell. Cells usually about 8 or 10 times as long as broad, but frequently longer. Sporangia non-aymmetrical, a single one being placed in the angle formed in each of the cells."

We have nothing to add to this description, never having seen the plant in question, and are able only to reproduce Hassall's figures.

Plate XLIV. fig. 3. *a*, sterile cells; *b*, fertile cells, after Hassall.

Order III. *SIPHOPHYCEÆ.*

Unicellular algæ, usually at the time of fruiting bicellular. Cells utricle-shaped, often prominently branched; branches with terminal vegetation, at length shut off by a septum, some transformed into oosporangia, others into antheridia. Cell contents green, mucilaginous, granulose, filled with chlorophyllose vesicles and starch granules.

Propagation by free cell formation, or zoogonidia, or oospores.

Plants aquatic or terrestrial, some marine.

Family I. Botrydiaceæ.—Propagation by free cell formation and by zoospores.

Family II. Vaucheriaceæ.—Propagation by oospores and zoogonidia.

Family I. BOTRYDIACEÆ.

Plants small, terrestrial, unicellular. Cell in the beginning globose, afterwards clavate or pyriform, and inflated; vertex rounded, a long time closed, attenuated downwards; base divided into delicate hyaline radicles, filled within with a mucilaginous green granulose cytioplasm, with age collapsing at the apex, and finally wasting away. Cell contents modified into an indefinite number of resting spores; spore contents, in germinating, becoming modified into a number of sexual zoospores conjugating and forming isospores.

Genus 52. **BOTRYDIUM.** *Wallr.*

Vegetative plants unicellular, increasing by cell division and zoospore formation; asexual uniciliate zoospores; sexual biciliate isospores, sometimes globular, and alike capable of germination, sometimes compressed and hexagonal, furnished with a few tuberculate thickenings.

See for information Braun's "Rejuvenescence," pp. 128, 193, 220, 274; Parfitt in "Grevillea," Vol. i., p. 103; Archer in "Grevillea," Vol. i., p. 105; Rostafinski and Woronin, "Ueber Botrydium granulatum," 1877; Lawson in "Trans. Bot. Soc., Edinburgh," vi., 424; Archer in "Quarterly Journal of Microscopical Science," 1878, pp. 446-452.

The following is a summary of Rostafinski and Woronin's researches on this genus:—

If a plant be placed in water, its contents become modified at the latter part of the day or at night into zoospores. Ultimately the wall swells, then bursts somewhere at the top, and the zoospores resulting from the division of the parietal stratum escape. If the plant be only moistened, the zoospores do not swarm out, but come to rest within the collapsed wall. Such were known to previous observers as "germ cells" or "gonidia."

The zoospores are elongate-oviform, 5-8 × 20 mm., with a single flagellum, and 2 to 4 chlorophyll granules. Having swarmed out, they soon come to rest, lose the flagellum, become surrounded by a membrane, increase in size, and germinate on damp earth, in which stage they represent the so-called *Protococcus botryoides.*

The large ordinary zoosporangia are also otherwise modified. If one is allowed to dry, its membrane collapses, loses colour, and soon becomes empty. The protoplasmic contents pass down to the ramifications of the root. Here they break up into numerous cells, sometimes two or three side by side, but chiefly in a continuous chain; each cell furnished with a separate membrane.

These are capable of three forms of development:—(1) If removed from the soil and placed in water, the cell becomes a subterranean zoosporangium. The formation of the zoospores is independent of light at any hour of the day or night. The zoospores are similar to those above described, and germinate in the same manner. (2) If a chain of these root cells be laid on moist earth, each protrudes a hyaline process, which enters the soil, the opposite end being elevated, and thus each root cell becomes a vegetative plant. (3) If the root cells are not removed, and kept equably moist, they also germinate in the earth, become inflated, put forth a root process, the wall of which becomes very much thickened on the inner side below the inflated upper portion. By intercalary growth of the root portion the upper part becomes raised aloft, so that the apex is carried above the surface of the soil. These products of modified root cells are named *hypnosporanges*, and are equivalent to so-called *Botrydium Wallrothii*. When dried, the hypnosporanges retain their power of germination during the whole year, and when placed in water form zoospores at any hour of the day and night, germinating and forming young plants as above.

The uniflagellate zoospores germinate on a moist substratum. On earth or sand they thrive badly, but better on clayey or muddy soil. In water they never germinate, but come to rest, are surrounded by a double membrane, and lie dormant for months. If these be transferred upon a clayey soil, they commence to form a vegetative plant. If the zoospores be sparingly distributed over the soil, and the whole kept equally moist, the vegetative plants become ordinary zoosporanges. The plants are sometimes modified into hypnosporanges.

Thus, vegetative plants can be increased by cell division directly from zoospores, become ordinary zoosporanges, with such consequences as root cells, &c., or they may be directly modified into hypnosporanges. But there is yet another way in which existence may be carried on. If exposed to drought, the following phenomena occur:—The wall collapses more or less, and the protoplasmic contents break up into a number of cells, each surrounded by a delicate membrane, its contents homogeneous, at first green, then passing into red. These are the *spores*, and have been known by such names as *Protococcus coccoma*, *P. palustris* and *P. botryoides*. These spores become changed in water to zoosporangia, their contents giving rise to zoospores in the manner already described. If the spores be still green, their zoospores will have a distinct fusiform figure, with two cilia at one end. They consist of slightly coloured protoplasm. These zoospores conjugate in twos, sometimes several together. They come in contact by their ciliated ends, then come to touch laterally by the uncoloured portions, when the fusion of the conjugating zoospores takes place, immediately after which they present a cordate figure, and in the middle a colourless vacuole. Finally, the *isospore* thus originating becomes globular, the vacuole occupying the centre.

If the zoospores be isolated before conjugation, they will in the end break up, without presenting any products capable of germination.

The zoospores originating from red spores have a different figure, their posterior end being rounded, but they have otherwise the same structure, and behave in the same manner as the others. The red spores maintain their germinative power for years, but after two years their zoospores are languid, and offer a parthenogenesis of a peculiar kind. The red spores, if kept moist only, become nothing altered after weeks, whilst the green, under these circumstances, may directly germinate into vegetative plants.

The *isospores* are at first globular, and capable of immediate germination. They also present resting stages, the original form becoming modified. Soon after conjugation these are flattened, with irregular lateral boundaries, which become on the following day hexagonal. The membrane becomes thickened, and presents tuberculations at the margin, but no secondary membrane is formed. Brought upon damp earth, they soon become globular, and otherwise behave as ordinary isospores.

In order to distinguish that which appertains to the cycle of alternation of generations from the rest, the simple method is to start from the fertilized germ, and see what are the modifications which are essential in order to arrive again at the same reproductive process. In this case we have the isospore—it germinates—produce the vegetative plant, which needs neither to divide, nor produce a sexual zoospore, nor to become an ordinary zoosporange—it can directly produce spores. These close the first generation. The second oospore generation occurs in the germination of these spores in the form of sexual zoospores, which directly lead to the formation of the isospore—the limits of two generations. All the rest are but phenomena of adaptation.

"Thus, in nature, the vegetative plants in spring almost all become zoosporangia, and spread the growth over considerable areas. Zoospores which fall into the water are not lost; they acquire a double membrane, and lie dormant until they chance mechanically to arrive on moist soil. If drought sets in, the plasma retreats to the roots; if the earth be some time a little moist, the root cells become hypnospores, awaiting the rain in order to develop multitudes of zoospores; but if the earth becomes rapidly dried, the root cells remain unaltered, until a moistening excites the formation of zoospores. A great many of the root cells can manifestly accidentally reach the surface of the soil, and thus, according to the state of the moisture of the earth or of the air, sometimes germinate, sometimes become zoospores." All this in the spring. The hotter months favour the formation of spores, but at that time only the vegetative plants are mostly to be found, either undergoing cell division or spore formation. They can also furnish uniciliate zoospores without becoming modified into ordinary zoosporanges.

Formation of ordinary zoospores may be accomplished in a fourfold way—

1. From the vegetative plant.
2. From the ordinary zoosporange.
3. From the root cell.
4. From the hypnosporange.

Further modes of increase are—

5. Cell division.
6. Formation of spores.
7. Formation of zoospores.

This plant possesses also fivefold resting stages—

1. Of the asexual zoospores laid in water—for months.
2. Of the root cells—the year throughout in which they originated.
3. Of the hypnosporanges—the year throughout in which they originated.
4. Of the spores—for years.
5. Of the isospores—at least over the year in which they originated.

Plate LXV., Botrydium granulatum. Fig. 1, plants of the natural size. Fig. 2, zoosporangium × 30. Fig. 3, the same, five hours afterwards, with the zoospores escaping at the apex, × 30. Fig. 4, zoospores × 520. Fig. 5, differentiation of the plasma in the root, and the formation of root cells, × 30. Fig. 6, root cells in water producing zoospores × 160. Fig. 7, the resulting zoospores × 520. Fig. 8, the same, 24 hours after swarming, × 520. Fig. 9, the same, four days later, × 520. Fig. 10, the same, eight days later, × 520. Fig. 11, copulating swarmspores × 520. Fig. 12, zoospores derived from a spore, after six and a half hours, × 160. Fig. 13, sexual swarmspores in conjugation × 520. Fig. 14, isospores, 24 hours old, × 520. Fig. 15, stellate isospores, more than a day old, × 520. Fig. 16, young plant resulting from vegetation of isospore. All after Rostafinski and Woronin.

Botrydium granulatum. *Linn.*

Usually gregarious, often aggregated, rarely confluent; cells globose, pyriform, size of a poppy seed, or mustard seed, or larger, leek-green, apparently pulverulent.

Botrydium granulatum, Jenn. Fl. Tunb. Wells 176. Parfitt in Grevillea i., p. 10. Eng. Fl. v., p. 321. Harv. Man. 150. Kirsch. Alg. Schl., p. 84. Trans. Bot. Soc. Edin. vi., 424. Eng. Bot. ii., p. 127, t. 2422. Hass. Alg. t. 77, f. 5.

Hydrogastrum granulatum, Rabh. Alg. Eur. iii., 265. Desv. Fl. Ang. 19.

Lichenoides fungiforme, Ray Syn. iii., p. 70.

Tremella palustris, Dillen. Hist. Musc. 55, t. x., f. 17.

Botrydium argillaceum, Grev. Alg. Brit., p. 197, t. 19. Kutz. Tab. vi., t. 54.

Vaucheria granulata, Grev. Fl. Ed. 306. Gray. Arr. i., 290.

Vaucheria radicata, Hook. Fl. Scot. ii., 93.

Vaucheria multicapsularis, Harv. Man. 149. Gray Arr. i., 252 (?).

Ulva granulata, Lightf. Fl. Scot. 976. Hull. Brit. Fl. 309.

Tremella granulata, Huds. Fl. Ang. 566. With. Arr. iv., 80. Eng. Bot. i., t. 324.

On the ground in swampy places.

"The plant about $1\frac{1}{2}$ mm. diam.; the upper portion, or that above ground, globular, gradually narrowing downwards, and passing into one or two principal roots, which become gradually ramified into many fine rootlets; the chlorophyll contents at the beginning dense and homogeneous, and clothing the inner cell membrane, extend only to the neck of the root; the membrane is rather rigid. Upon being broken the cell contents become extruded, the membrane collapses as a thick pellicle, whose contents admit of being completely pressed out. The fluid contents in this condition consist of finely granular plasma, tinged by chlorophyll granules. Subsequently the green plasma layer becomes separated from the membrane, breaks up into single equal-sized portions, which become rounded off, coated with a membrane, and gradually individualized as daughter-cells. At last the entire globose cell is densely filled with rounded daughter-cells; whilst, previous to this state, the plant presented an intensely grass-green colour, it shows in this latter state a clear or sea-green colour. Mature and immature plants hence readily admit of being distinguished by the tint with the unassisted eye. The membrane of the mother individual at last passes to decay; it collapses, and the daughter-cells become the germs of new individuals in the soil. The maturity of the individuals occurs towards autumn, and accordingly the germ cells lie resting in the earth during winter, and germinate in the following spring. The development of the germ cells to new individuals takes place without formation of a 'prothallus' ('ohne Vorkeimbildung'). One end elongating as a root, at once penetrates the earth; the other end becomes developed as the above-ground portion. The diameter of a ripe germ cell is 0·009-0·012 mm. The plants prefer to establish themselves on the surfaces of the large clefts which are produced when the waters retreat and the ground becomes gradually dried by the air."—*Reinsch. Algen Flora*, p. 218.

See also "Grevillea" Vol. iv., p. 105, since which period the Memoir by Rostafinski and Woronin has appeared, and that has pretty well established the complex character of reproduction in this little plant.

Family II. VAUCHERIACEÆ.

Algæ monæcious (rarely diæcious), cæspitose, unicellular or bicellular. Thallus with terminal vegetation, utricle-shaped, elongated, more or less branched.

Propagation either sexual, by oospores fecundated by spermatozoids, or non-sexual by zoospores.

Sporangium terminal, formed by the globosely clavate swelling of the tip of the thallus, cut off by a septum, contents dark green, at length enclosing one large zoospore, densely clad with vibratile cilia.

Oogonium lateral, sessile, or borne on a more or less elongated simple, or partite, pedicel; cytioplasm at length converted into a large oospore.

Antheridium lateral, sessile, or cut off by a septum from the upper portion of a lateral branch, in which numerous spermatozoids are generated, which at length become free. Spermatozoids oblong, furnished with two unequal cilia (except in one species).

Consult Thuret in "Annales des Sciences Naturelles, Botanique," 1843. Walz in Pringsheim's "Jahrbucher" for 1866. Braun "Rejuvenescence," pp. 128, 140, and following.

GENUS 53. **VAUCHERIA.** *D. C.* (1805.)

Characters the same as given above for the Family.

Two or three arrangements of the European species of *Vaucheria* have been proposed, differing slightly in detail. The following is that of Professor Nordstedt:—

VAUCHERIA.

A. Antheridia not separated from the thallus by a short empty boundary cell.

a TUBULIGERÆ. Antheridia little or scarcely bent, oblong cylindrical, or lanceolate, with an opening at the top. Red pigment bodies *not* collected in the middle of the mature oospore. Oogonia and antheridia almost stemless.

* Oogonia nearly round.

1 *V. dichotoma* (L) Diæcious.

2 *V. Thuretii* Wor. Monæcious.

** Oogonia not round, more or less oval, frequently rather oblique.

3. *V. aversa*, Hass.

4. *V. sericea*, Lyngb.

b CORNICULATÆ. Antheridia bent in the form of a horn, or a hook, placed on the short and bent side branches of the thallus. Brown pigment in the middle of the mature oospores.

aa *Sessiles.* Oogonia sessile (or with exceeding short stems) beside the antheridia on the thallus.

5. *V. Dillwynni*, Ag.

6. *V. sessilis* (Vauch).

bb *Racemosæ.* Antheridia at the end of a fruit branch, which, somewhat lower down, carries the oogonium.

* Oogonia turned upwards.

† Antheridia and oogonia bending in opposed planes, forming an angle with one another. When the oospores fall they are surrounded by the oogonium membrane, which is not changed to slime.

7. *V. geminata*, Walz.

8. *V. hamata*, Walz.

†† Antheridia and oogonia (mostly) bending in parallel planes, the oogonium membrane turns to slime and dissolves.

9. *V. terrestris*, Lyngb.

** Oogonia turned downwards.

10. *V. uncinata*, Kutz.

c Antheridia straight, with the top covered, and a pair of fruiting tubes standing out at the side.

11. *V. De Baryana*, Woron.

B. Between the antheridia and thallus itself is found a shorter empty boundary cell (not containing chlorophyll).

a ANDROPHORÆ. Several horn-shaped bent antheridia placed on a swollen cell containing chlorophyll, which is fixed to the side of the thallus, by means of the boundary cell.

12. *V. synandra*, Woron.

b PILOBOLOIDEÆ. Antheridia bordering immediately on the boundary cell (frequently provided with several mouths).

aa Oogonium borders immediately on the thallus branch.

* Several fructification tubes on the oogonium.

13. *V. coronata*, Nordst.

** Oogonium with only one fructification opening, but the antheridia with several.

† Oospore round.

14. *V. intermedia*, Nordst.

15. *V. sphærospora*, Nordst.

† † Oospore lens-shaped.

16. *V. piloboloides*, Thur.

bb Below the oogonium a boundary cell.

17. *V. litorea*, Hofm.

Place uncertain.

18. *V. tuberosa*, Br.

19. *V. trifurcata*, Kutz.

The sexual reproduction in *Vaucheria* has been minutely described by Pringsheim, of which we give an abstract. *Vaucheria*, besides the asexual multiplication by zoospores also exhibits a true sexual propagation, effected by means of the two organs known as the "hornlets" and the spores, the latter being more correctly termed "sporangium." Both organs arise like papillary branches from the tube, and in close proximity. It is usually the case that the papilla destined to become the hornlet is formed sooner than that in which the sporangium originates. The two papillæ even from the first differ so widely in dimensions, that they can scarcely be confounded. The papilla which becomes the hornlet soon elongates into a short cylindrical slender branch, which at first rises perpendicularly from the tube, then curves downwards until it comes in contact with the tube, often forming a second, or a third curve, and in this way always represeuts a more or less stunted branch, which frequently exhibits several spiral turns. The papilla of the neighbouring sporangium usually begins to appear at the time when the hornlet is commencing its first turn ; but the period at which it arises is very indeterminate, for it sometimes appears much earlier, whilst the hornlet is still perfectly straight, sometimes much later after it has curved, so as to form two limbs of equal length.

The papilla destined to become the sporangium gradually enlarges into a considerable-sized lateral out-growth of the tube, far exceeding the hornlet in width, whilst in length it is barely equal to the straight limb of the latter. This out-growth which is afterwards symmetrical, ultimately throws out a beak-like prolongation ou the side looking towards the hornlet, the rostrum of the sporangium, whence the latter acquires its peculiar form, resembling that of a half developed vegetable ovule. Up to this period the hornlet as well as the sporangium are not shut off from the tube by any septum ; the cavity of the hornlet and that of the sporangium consequently remain uninterruptedly continuous with the parent tube, and are filled with similar contents. A number of chlorophyll granules in an albuminous plasma and rounded oil globules, constitute a dense lining to the tube, the sporangium, and the hornlet. Between this and the cellulose membrane is the thin colourless cutaneous layer.

At this stage a septum is suddenly formed at the base of the sporangium, which is henceforth an independent cell, completely separated from the parent tube. Even before this septation there may be noticed in the rostrate elongation directed towards the hornlet, the gradual accumulation of a colourless fine granular substance, of the same nature as that with which the wall of the parent tube, and the sporangium is lined on the inner surface, which has already been termed the "cutaneous layer." This accumulation in the fore part of the rostrum is continued after the formation of the septum between the sporangium and the tube, and in consequence of its continued increase, the remaining contents of the sporangium are by degrees pushed back towards the base. Whilst these phenomena are being manifested in the sporangium, the hornlet also undergoes remarkable changes. In its apex, the contents, owing to the disappearance of the chlorophyll, have become almost colourless, more or less. Thus the point of the hornlet, like that of the sporangium, appears at this time to be filled with a colourless substance, which is *not* constituted by an accumulation of the cutaneous layer, but manifestly arises from a molecular change associated with an alteration of form and colour in the contents previously existing at the apex. So soon as the contents at the point of the hornlet have thus become colourless, they appear to be constituted of a very fine-grained granulose mucous substance. As soon as the transformation of the contents has taken place, the colourless apex of the hornlet is suddenly separated from the lower green portion by a septum, and is thus transformed into an independent cell, without communication with the parent tube. The point at which the septum is formed is not very determinate, the portion cut off being sometimes larger, sometimes smaller.

After the formation of the septum in the hornlet the colourless mucous in its apex gradually assumes a more determinate form, and at this time a large number of minute, perfectly colourless, rod-like bodies may be readily perceived crowded together irregularly, and as it were imbedded in the surrounding mucous. Close observation will disclose an indistinct movement exhibited even thus early by some of the little rods, from which their destination may be anticipated.

This perfecting of the hornlet coincides with that stage of development of the sporangium at which the accumulation of the cutaneous layer in the anterior part of the rostrum has attained its greatest extent, and these conditions immediately precede the act of impregnation, which is effected in the following manner :—

The pressure within the sporangium, especially in the direction of the rostrum, becomes greater and greater in consequence of the continued increase of the cutaneous layer in the fore part, until ultimately the membrane is ruptured exactly at the point of the rostrum, and allows a portion of the cutaneous layer to escape. The extruded portion becomes detached, and assumes the character of a drop of mucous, which remains lying near the opening of the sporangium, and ultimately perishes. The accumulation of the cutaneous layer in the fore part of the rostrum, and the escape of a portion of it, are merely the mechanism by which the opening is produced in the sporangium destined for the admission of the spermatozoids. Immediately after the formation of this opening in the sporangium, and in remarkable coincidence with the escape of the cutaneous layer through the rostrum, the hornlet opens at the apex, and pours out its contents. Innumerable excessively minute rod-like corpuscles (·005 mm.), mostly isolated, escape at once through the orifice. Those already isolated exhibit an extraordinarily rapid movement in all directions, and those still imbedded in the mucous do not become detached until afterwards, when they follow the others with equal rapidity. The field of view is soon covered with mobile corpuscles.

In great number (20, 30, or more) they enter the neighbouring orifice of the sporangium, which they fill almost entirely, penetrating through the portion of the cutaneous layer remaining, which, though without any definite boundary, offers a solid resistance to their further penetration into the sporangium. The corpuscles continue thus to struggle forwards into the cutaneous layer for more than half an hour, bounding against its outer surface they retreat, again push forwards, again retreat, and so on, in an uninterrupted succession of assaults and retreats.

After this commotion has lasted some time, an abrupt boundary line suddenly appears in the outer aspect of the cutaneous layer, the first indication of a tunic forming around the contents of the sporangium which were before bare. From this moment the mobile corpuscles are separated from the cutaneous layer by a membrane which effectually prevents their further action upon the contents. They continue, it is true, to move to and fro, and this movement often lasts for hours together, but at last they perish in the rostrum itself. Even after the lapse of several hours the dead corpuscles may be seen in the rostrum, lying on the front of the sporangium, until at last they are completely dissolved, and all vestige disappears.

The cutaneous layer surrounding the green contents of the sporangium becomes transformed, after impregnation, into the coat of the true spore, which, thus formed, represents a large cell occupying the whole of the sporangium, surrounded on all sides by the persistent tunic, which is open in front and prolonged into the rostrum.

In this condition the spore remains for some time longer without being thrown off from the parent tube on which it was produced, but the colour of its contents gradually becomes paler and paler. The spore is at last rendered quite colourless, and presents in its interior only one or more largish dark brown bodies. When it has lost all colour it is detached from the parent tube, in consequence of the decay of the membrane of the sporangium enclosing it. After some time, say three months, the spore suddenly resumes its green colour, and immediately thereupon grows into a young *Vaucheria* exactly resembling the parent plant.

An abstract of the memoir from which the above details were obtained was published in the "Quarterly Journal of Microscopical Science" for 1856. (Vol. iv., p. 63).

During the present winter Mr. Frederic Bates, of Leicester, has called our attention to some plants of *V. sessilis*, taken from beneath the ice in a pool. The first feature which presented itself was the septation of the threads, many of them being divided into numerous articulations three or four times the length of the diameter in the upper portion of the thread, but longer below. This unusual septation, as it appears to be, was general throughout the gathering, but the threads bearing oogonia were more rarely divided, but sufficiently so to remove any doubt as to the threads being genuine threads of *Vaucheria*, which at first we must confess to have doubted. The question which next arose was as to the purpose for which this septation had taken place, and an answer suggested itself in the collection of the cytioplasm into denser masses towards the centre of the cell, with most evident differentiation into oval bodies, resembling zoogonidia in course of formation. The time of observation has been short, but long enough to raise a suspicion in our minds that another form of fructification, by means of zoogonidia, takes place in *Vaucheria*, and the occurrence of germinating spores in various early stages in the water in which the *Vaucheria* was being preserved, lends strength to this suspicion. It is quite true that *Vaucheria* has been often and patiently studied, and no intracellular swarm-spores detected; yet it may be possible that, under certain conditions, they may be produced. We are patiently waiting in hopes of obtaining active zoogonidia.

The plates for this part were all in course of printing when the above observations were being made, so that it was too late to insert figures of the septate threads and their contents.

Plate XLVI. Figs. 1-20. Impregnation of *Vaucheria sessilis* after Pringsheim × 200.

Figs 1-4. Stages of development of sexual organs before impregnation. Fig. 5. During impregnation. Figs. 6-8. The way in which the female organ opens the cutaneous layer, bursts through, and a portion is constricted off. Fig. 9. Approach of spermatozoids before formation of the membrane of the embryo cell. Fig. 10. Point of female organ after formation of the membrane of the true spore. Figs. 11-12. Later conditions of spore after impregnation. Figs. 13-16. Male and female organs after impregnation. Fig. 17. Colourless spore after it is detached from the parent tube. Fig. 18. Detached spore, which after resting three months has become green. Figs. 19-20. Germination of the green spores.

a. TUBULIGERÆ. *Antheridia little or scarcely bent.*

1. Vaucheria dichotoma. *Lyngb. Hydro. Dan. p.* 75, *t.* 19.

Robust, loosely cæspitose, dirty green, or becoming brownish. Thallus very thick, setaceous, nearly a foot long, remotely dichotomous. Oogonia sessile, globose, or ovoid, single, scattered, or 2 to 4 to 6 approximating. Oospores, when mature, with a triple membrane, spotted with brown. Antheridia single, erect, oval, sub-clavate, or acute, on the same or on different threads.—*Rabh. Alg. Eur.* III. 268.

SIZE. Oogonia ·1 mm. diam. Threads ·2 mm. diam.

Walz in Pringsh. Jahrb. p. 152, t. xiv. f. 28-33. Fl. Danica t. 1724. Harv. Man. p. 147. Grev. Br. Alg. p. 190. Gray. Arr. i., 289. Kirsch. Alg. Schl. p. 82. Eng. Bot. ii., t. 2418. Grev. Fl. Ed. 305. Mack. Hib. 233. Fl. Devon ii., 56. Kutz. Tab. vi., t. 56a. Hass. Alg. t. 4, f. 1. Eng. Fl. v., p. 319. Nordst. Bot. Not. 1879, p. 184. Jenner Fl. Tunb. Wells, 176.

Conferva dichotoma, Linn. Spec. 1635. Dillw. Conf. t. 15. Eng. Bot. t. 932. Huds. Fl. Ang. p. 593. Withering iv., p. 49. Hull Br. Flora, 330.

Vaucheria globifera, De Bary Monats. 1856, p. 589. Rabh. Alg. Ex. No. 640.

Vaucheria salina, Kutz. Tab. vi., t. 66, f. 2.

Conferva Plinii setis porcinis, Ray. Syn. 58.

Conferva dichotoma setis porcinis, Dillen. Musc. 17, t. 3, f. 9.

var. β **submarina.** Ag. Syst. p. 171.

Vaucheria submarina, Berk. Glean. p. 24, t. 8. Harv. Phyc. Brit. t. 350 B. Harv. Man. 147.

In ditches, and in brackish and salt water.

Hassell was of opinion that this species did not differ specifically from *Vaucheria sessilis*, but the two are now regarded as belonging to different sections. Nordstedt says that it is diœoious, but no reference is made to this fact by Walz.

Plate XLVI. fig. 21. Oogonia of *Vaucheria dichotoma* × 100 diam. Fig. 22. Oogonium × 200. Fig. 23. Antheridea × 100. Fig. 24. Antheridium × 200, after Woronin. Fig. 25. Germinating spore.

Plate XLIX. figs. 5, 6. The *V. submarina,* Berk., generally referred to this species as a variety.

2. Vaucheria aversa. *Hass. Alg. t.* 6, *f.* 5.

Loosely cæspitose, sparingly branched, expanding in all directions, organs of fructification similar to those of *V. sericea,* but with the thallus much thicker, the oogonia larger, and suberect, now and then somewhat pedicellate ; oospores much smaller.

Hass. Ann. Nat. Hist. xi. (1843), p. 429. Walz in Prings. Jahrb. p. 151, t. 13, f. 25-27. Cleve. Vauch. 133, f. 7.

Vaucheria rostellata, Kutz. Tab. vi., t. 58, f. 4.

In ditches.

Hassall describes this species as " Capsules usually in pairs, and in the form of a bird's head, with the beaks averted from each other. Sporangia circular, not entirely filling the cavity of the capsule." To this he adds, " It is one of the best marked, and most peculiar of the genus, the beaks of the capsules being turned in opposite directions, at once distinguish it from all other known species, in which, when the vesicles are in pairs, they are directed towards each other. This averted position of the capsules renders the existence of a distinct horn or anther essential for each. In the form of the seed-vessels and in the circumstance of the sporangia not filling the entire cavity, the species resembles *V. ornithocephala*" (now regarded as a variety of *V. sessilis*).

Plate XLVII., fig. 1. Oogonia and antheridia of *Vaucheria aversa* × 100. Fig. 2. The same × 200. Fig. 3. Mature oospore in oogonium × 200, after Walz.

3. Vaucheria sericea. *Lyngb. Hydro. Dan. t.* 21, B.

Tufts densely interwoven, yellowish, dirty green, or becoming brownish ; thallus thin, loosely and vaguely branched ; oogonia 2 to 6 in a series, one sided, oblique oval, rostellate, mouth produced laterally, sessile or shortly pedicellate ; antheridia cylindrical, or rather clavate, horizontally deflexed. Spermatozoids oblong, with a red spot, furnished with a cilium at each pole.

Size. Oogonia ·1 mm. diam.

Walz in Prings. Jahrb. p. 150, t. xiii., f. 20-24.

Vaucheria ornithocephala, Ag. Sp. Alg. p. 467. Grev. Alg. Br. p. 193. Harv. Man. p. 148. Rabh. Alg. Exs. No. 1100. Nordst. Bot. Not. 1879, p. 184.

Vaucheria polysperma, Hass. Ann. Nat. Hist. xi. (1843), 429. Hass. Alg. t. 6, f. 6. Kutz. Tab. vi., t. 58, f. 5. Rabh. Alg. Exs. No. 1375. Cleve Vauch. p. 7.

In ditches, &c.

This is the *Vaucheria polysperma* of Hassall, who says of it: "It is by no means uncommon, and may be distinguished from all others known to me by the fineness of its filaments, which are not half so large as those of our other British species, no less than by the form and arrangement of the sporangia. These are slightly pedunculate, varying in number from 3 to 5, but usually there are but three, the apices or beaks of which are neither turned towards or averted from each other, but are all directed one way. The resemblance which the capsules bear to a bird's head when viewed sideways is very remarkable, and this resemblance is rendered still more striking by the fact that the circular sporangium occupying only the central portion of each, and which therefore represents the eye of the bird.'

Plate XLVII., fig. 4. Oogonia and antheridia of *V. sericea* × 200. Fig. 5. Oogonia containing oospores × 200. Fig. 6. Mature oospore enclosed in an oogonium × 200, after De Bary. Fig. 7. Zoospore × 200, after Walz. Fig. 8. Spermatozoids.

b. CORNICULATÆ. *Antheridia bent in the form of a horn or a hook, seated on short lateral branches.*

4. Vaucheria Dillwyni. *Ag.*

Terrestrial, broadly expanded, forming a rather thin stratum, of bright or dark green colour. Oogonia globose, or ellipsoid, rostrate, sessile, usually single, sometimes in twins, enclosed in delicately punctate membrane. Mature oospores spotted with brown, sporoderm very thick, composed of several strata. Antheridia bag-shaped, formed from the apices of short lateral curved branches, either approximate to the oogonia or seated between a pair of them.

Rabh. Alg. Eur. iii., 269. Grev. Alg. Britt. t. xix. Hass. Alg. t. 4, f. 3. Eng. Fl. v., p. 320. Jenner Tunb. Wells 176. Eng. Bot. ii., p. 124. Harv. Man. 147. Johnst. Fl. Berw. ii., 251. Grev. Fl. Edin. 305. Mack. Hib. 234. Fl. Devon ii., 56. Hook. Fl. Scot. ii., 93. Gray Arr. i., 290.

Vaucheria Ungeri, Thur. Ann. Sci. Nat. xix. (1843), t. 13, f. 43 ?

Vaucheria pachyderma, Walz Jahrb. p. 146, t. 12, f. 1-6.

Conferva frigida, Dillw. Conf. t. 10. Harv. Man. p. 147.

Conferva amphibia fibrillosa et spongiosa, Ray. Syn. p. 59.

On the ground in damp shady places.

It is presumed that this is the same species as has been described by Walz under the name of *Vaucheria pachyderma*, but the synonyms of some of these species are a little mixed. Dillwyn says: "It is not unfrequently found in turnip fields during the winter and early months of the spring, particularly in a northern exposure, and on a cold soil. The patches vary in size, but are usually two or three inches in extent, adhering but slightly to the soil, and consisting of loose unconnected filaments." "The form of the capsules, which are rarely pedunculated, will at once distinguish this from all other species," says Hassall, "which have hitherto been described."

Plate XLVII., figs. 9, 10. Oogonia and antheridia of *V. Dillwyni* × 200. Fig. 11. Oogonium of the same × 200. Fig. 12. Mature oospore enclosed in membrane of oogonium × 230, after Walz. Fig. 13. Spermatozoids.

5. Vaucheria sessilis. *Vauch. Conf. p.* 81. *pl.* 2, *f.* 7.

Loosely intricate, pale or rather dull green. Thallus capillary, sparingly branched; oogonia 2 to 3 approximate, rarely single, ovate or oblong-oval, more or less oblique, rostrate; antheridia intermediate, either short, hamate, or straight and subulate, or a little clavate, sometimes elongated and incurved, rarely circinate. Mature oospores punctate with brown, involved in a triple membrane.

SIZE. Oospore ·07 mm. diam., thread ·07 mm. (Cleve).

Eng. Fl. v., 320. Cleve Vauch. 133, f. 6. Kirsch Alg. Schl. 82. Walz Vauch. p. 145. Kutz. Tab. vi., 59, f. 2. Hass. Alg. t. 4, f. 2. Eng. Bot. t. 1765. Harv. Man. p. 148. Grev. Alg. Br. p. 192. Jenner Tunb. Wells 176.

Vaucheria sphærocarpa, Kutz. Tab. vi., t. 59, f. 1.

Vaucheria racemosa, Rabh. Alg. Sachs. No. 495.

Vaucheria Ungeri, Thur. Ann. Sci. Nat. xix. (1843), t. 11, 12, 13, f. 37-42 and 44.

Sporangia.—

Vaucheria clavata, Vauch. Conf. t. 3, f. 10. Hass. Alg. 59, t. 2, f 20-33. Harv. Man. 149. Berk. Glean. t. 10. Gray. Arr. i., 290.

In ditches, or on the ground.

var. a. **cæspitosa.** *Vauch. Conf. p.* 26, *t.* 2, *f.* 4.

Oogonia usually in pairs, ovate, opposite. Antheridia intermediate, generally short, circinate.

Vaucheria cæspitosa, Carm. Eng. Fl. v., p. 321. Eng. Bot. 1, t. 2841, ii., t. 2421. Hook. Fl. Scot. ii., 92. Jenner Tunb. Wells, 176. Grev. Alg. Britt. 194. Harv. Man. 148. Johnst. Fl. Berw. ii., 251. Hull Br. Fl. 330. Abbot. Bedf. 275. Mack. Hib. 234. Gray Arr. i., 291.

Conferva amphibia, Dill. Conf. t. 41. With. Arr. iv., 129. Huds. Fl. Ang. ii., 594. Lightf. Fl. Scot. 979. Sibth. Ox. 336.

Conferva amphibia fibrillosa et spongiosa, Dill. Musc. t. 4, f. 17.

Conferva terrestris exilis fibrillosa, Ray. Syn. 59.

On the margins of streams or pools.

"Fronds densely interwoven into cushion-like tufts or strata of indefinite extent, irregularly branched, the tips erect, giving the surface the appearance of bright green velvet."—*Harvey.*

Dillwyn's description of his *Conferva amphibia* seems to be most applicable to this species. "On the edges of ditches, and in similar situations, it frequently occurs in masses so densely matted as to hold water like a sponge, with its surface beset by erect branches which give it a very bristly appearance. In this state it is well known to botanists as the *C. amphibia* of all modern authors. Its hue is of a bright green, becoming ash-coloured with age. The root I have not been able to discover, and the entangled mode of its growth renders it impossible to ascertain the length of the filaments. These are repeatedly divided with distinct patent branches, which, as before mentioned, when the plant grows in shallow water, so that some of them are exposed to the air, send out patent ramuli, of a stunted growth, from being out of their proper element, which by their erectness give the plant its bristly appearance; yet at the same time, if whilst in this state the waters rise so as to overflow the plant, their length is gradually increased, and losing their erect position they yield to the current, and become the *Ceramium cæspitosum* of Roth; and after having thus changed, if by the subsidence of the waters the surface is again exposed to the air, the filaments, of course disposed horizontally, give the plant a bristly appearance by again throwing out erect patent ramuli."

var. **ornithocephala.** *Hassall Alg. t.* 6, *f.* 4.

In dirty green tufts, densely imbricated, and becoming paler. Thallus loosely branched. Oogonia solitary, or in pairs, oval-oblong, obliquely rostrate, beaks truncate, antheridia cylindric-subulate, incurved, interposed, usually exceeding in length the diameter of the oogonia.

Vaucheria ornithocephala, Eng. Fl. v., 320. Harv. Man. 148. Hook. Fl. Scot. ii., 93. Eng. Bot. ii., p. 195. Grev. Alg. Britt. 193. Grev. Fl. Ed. 306. Fl. Devon. ii., 56. Gray Arr. i., 291.

Conferva vesicata, Dillw. Conf. t. 74.

In stagnant or slow-flowing water.

var. **repens.** *Hassall Alg. t.* 6, *f.* 7. *Ann. Nat. Hist.* XI., 430.

Terrestrial. Oogonia single, sessile, oblong or ovate, shortly rostellate, mouth lateral, truncate. Antheridia solitary, next the oogonium, cylindric-clavate, erect, inclined or curved, scarcely longer than the oogonium.

On the naked ground.

It is on *Vaucheria sessilis* that Sir J. E. Smith says are found th "Vesicles of the nature of galls, perhaps, inhabited by Muller's *Cyclops lupula*," figured on plate 2419 of the second edition of English Botany. Hassall states that the species is *V. geminata*, but this is accounted for by the belief which was current in those days that *V. geminata* was the summer form of *V. sessilis*.—See *Eng. Bot. ed.* II., p. 125.

Plate XLVI., figs. 1 *to* 20. Impregnation of *Vaucheria sessilis*, after Pringsheim × 200.

Plate XLVIII., fig. 1, part of thread, with sexual organs, of *V. sessilis.* Fig. 2, oogonia and antheridia × 200. Fig. 3, oogonia and antheridium of the variety *cæspitosa* × 300. Fig. 4, oogonia and antheridium of the terrestrial variety *repens* × 200. Fig. 5, threads bearing sporangia at the tips slightly magnified.

6. Vaucheria geminata. (*Vauch.*) *Walz. Jahrb. p.* 147, *t.* 12, *f.* 7-11.

Dark or dull green, in dense intricate tufts. Thallus capillary, tough, dichotomous. Oogonia two (rarely 1 or 3), ovate or obovate, opposite, distinctly pedunculate. Antheridia intermediate, subulate, more or less recurved. Mature oospore spotted with brown, sporoderm colourless, composed of three strata. Sporangia on the same or a proper thallus, broadly cup-shaped, truncate, and angularly horned.

SIZE. Oospore ·11-·12 × ·18-·19 mm.

DCand. Fl. Fr. ii., 62. Hass. Alg. t. 3, f. 1. Cleve Vauch. p. 6, f. 4. Kirsch. Alg. Schl. p. 83. Kutz. Tab. Phyc. vi., t. 59, f. 3. Eng. Fl. v., 320. Harv. Man. 148. Eng. Bot. i., t. 1766, ii., t. 2420. Grev. Alg. Britt. p. 193, t. 19. Purton Mid. Fl. ii., 611. Johnst. Fl. Berw. ii., 252. Grev. Fl. Ed. 306. Fl. Devon. ii., 56. Gray Arr. i., 291.

Ectosperma geminata, Vauch. Conf. 29, t. 2, f. 5.

Vaucheria Dillwyni, Rabh. Alg. Sachs. No. 1078.

To this species we also refer the following as synonyms, although usually referred to *V. sessilis*:—

Vaucheria ovoidea, Hass. Alg. 57, t. 5, f. 3.

Vaucheria ovata, Gray Arr. i., 289.

Ectosperma ovoidea, Huds. Fl. Ang. 954. Hook. Fl. Scot. 979. With. Arr. iv., 129.

In ponds and ditches.

var. β **racemosa.**

Oogonia shortly pedunculate, 3 to 5 or more aggregated in a corymbose manner. Antheridia single, scarcely longer than the oogonia.

SIZE. Oospore ·06-·08 × ·075-·08 mm.

Vaucheria racemosa, Eng. Bot. ii., 126. Grev. Alg. Britt. 195. Harv. Man. 149. Grev. Fl. Ed. 306. Gray Arr. i., 292. Hass. Alg. 56, t. 3, f. 2.

We have reproduced Hassall's figure of this form in which the antheridium is considerably longer than the oogonia. Vaucher says, "This species is one of the most common, and is found in nearly all ditches, principally in the spring. It is loaded with little bouquets manifest to the unassisted sight, and which with the microscope seem to be formed of a common peduncle, subdivided into pedicels, each of which carries on its summit a spherical body in every way resembling the grains of other ectosperms, but nearly half as small again. In the middle of this bouquet is the horn, which, without doubt, performs the function of a male flower, and which is here but a prolongation of the peduncle. The number of grains varies from 5 to 7, but commonly 4 are met with."

It is of this species that Hassall says, "It is most frequently infested with the curious parasite *Cyclops lupula* of Muller, which occasions the growth on the filaments of such extraordinary-looking appendages, in the midst of which the parasite resides." This parasite, whatever it may be, was the subject of a communication by Mr. A. Lister to the Essex Field Club, July 22, 1882, and will be found in the "Proceedings" of the Club (Vol. iii.).

Plate XLVIII., figs. 6-7. Oogonia and antheridia of *V. geminata* × 200. Fig. 8, non-sexual spores of the same × 200, after Walz. Fig. 9, mature oospore × 200.

Plate XLIX., fig. 4, fruiting branch of the variety *racemosa*, after Hassall.

7. Vaucheria hamata. (*Vauch.*) *Walz. p.* 148, *t.* XII. *f.* 12-17.

Aquatic or terrestrial, thallus rather rigid, vaguely branched. Oogonia usually single, ovate or ovate-hemisphærical, seated on a short segment of the divided stem, the other segment elongated, curved, forming the antheridium. Mature oospores involved in a sporoderm formed of four or more strata.

Cleve Vauch. p. 6. Hassall Alg. t. v., f. 1. Gray Arr. i., 289.

Ectosperma hamata, Vauch. Conf. 26, t. 2, f. 2. Hass. Ann. Nat. Hist. xi., p. 439.

Vaucheria hamulata, Kutz. Tab. Phyc. vi., t. 61, f. 2.

In ditches.

Vaucher wrote of this species—"It differs from all others by the manner in which it carries its grains. The peduncles which sustain them are much elongated, and they bear at their extremity two little threads, the one is recurved and receives the anther, the other is shorter and straighter, and carries the grain."

Plate XLVIII., figs. 10, 11. Oogonia and antheridia of *V. hamata* × 200. Figs. 12, 13, mature oospores free from oogonia × 200. Fig. 14, sporangium × 200.

8. Vaucheria terrestris. *Lyngb. Hydro. Dan. p.* 77, *t.* 21, *f.* A.

Densely interwoven in a thin bright emerald stratum. Oogonia usually single, pedunculate, attached by the flattened base at the back of the incumbent elongated curved antheridium. Mature oospores enclosed in a hyaline colourless sporoderm composed of four strata, considerably inflated.

Eng. Flora v., 320. Grev. Alg. Britt. p. 191. Eng. Bot. ii., p. 124. Jenner Tunb. Wells, 176. Harv. Man. 148. Johnst. Fl. Berw. ii., 251. Mack. Hib. 234. Gray Arr. i., 290. Hass. Alg. 53, t. 5, f. 2. Berk. Glean. t. 9. Walz. Jahrb. p. 149, t. xiii., f. 18, 19. Rabh. Alg. Eur. p. 270. Cleve Vauch. 131, f. 1.

Ectosperma terrestris, Vauch. p. 27, t. 2, f. 3.

Vaucheria circinata, Kutz. Tab. vi., t. 60, fig. 2.

Forming patches on damp and clayey soil.

"Threads more straight and rigid than in *V. Dillwyni*, forming a more lax and less interwoven stratum, the summits of the little branches often erect, and giving the whole a bristly appearance."—*Greville.*

Plate XLIX. figs. 1, 2. Oogonium and antheridium of *V. terrestris* × 200. Fig. 3, mature oospore of same, after Walz × 230.

Plate XLIX., fig. 7. Oogonium of *V. velutina*, Ag. (a marine species), after Harvey × 200.

ORDER IV. *NEMATOPHYCEÆ.*

Multicellular algæ, chlorophyllose, membranaceous or filamentous, with or without branches. Vegetation either terminal, limited or unlimited, forming an articulate thread, or in the beginning terminal, and afterwards lateral, forming a membranaceous thallus of a single stratum. Cell multiplication by repeated division in one or two directions.

Propagation by oospores, or by zoogonidia.

Divided into the following families :—

A. Vegetation by division of the cells at first in one, and afterwards in two directions, forming a membranaceous thallus.

FAMILY I. ULVACEÆ.—Thallus membranaceous formed of one stratum of cells, either plane or expanded, or tubular, or saccate.

B. Vegetation by division of the cells in one direction, forming a cellular series or articulate thread.

FAMILY II.—SPHÆROPLEÆ.—Articulate thread not branched, articulations greatly elongated, cylindrical, multilocular, chlorophyll mass distributed in ring-like bands.

Propagation by resting spores, which, before germination, break up into zoospores.

FAMILY III. CONFERVACEÆ.—Articulate thread, simple or branched, vegetative articulations cylindrical, fructiferous always more or less swollen. Chlorophyllose mass effused, or parietal, often more or less regularly spiral.

Propagation by macro- and micro-gonidia.

FAMILY IV. PITHOPHORACEÆ.—Cladophora-like plants, with terminal vegetation. Articulate threads branched.

Propagation by neutral, quiescent, cask-shaped spores (agamo-hypnospores).

FAMILY V. ŒDOGONIACEÆ.—Articulate thread either branched or not branched ; articulations short.

Propagation by oospores after sexual fecundation.

FAMILY VI. ULOTRICHEÆ.—Articulate thread not branched, sometimes laterally connate; articulations short, at times very short.

Propagation by macro- and micro-gonidia.

FAMILY VII. CHROOLEPIDÆ.—Aërial algæ. Articulate thread branched, cell membrane firm, filled with an equally distributed oleaginous golden or reddish endochrome.

Propagation by zoogonidia.

FAMILY VIII. CHÆTOPHOREÆ.—Aquatic algæ. Articulate thread dichotomously branched, ramuli sometimes aggregated in a fasciculate or penicellate manner. Chlorophyllose mass usually collected in transverse bands.

Propagation by zoogonidia.—*Rabh. Alg. Eur.* III, 286.

FAMILY I. ULVACEÆ.

Thallus membranaceous, or foliaceous, rarely crustaceous, formed of one stratum of cells, either expanded, or tubulose, or vesiculose.

Propagation by zoogonidia, arising from a repeated division of the cytioplasm. Zoogonidia oblong, furnished at one extremity with two or four cilia.

Sub-Family 1. PRASIOLEÆ.

Thallus expanded and foliaceous, rarely crustaceous.

GENUS 54. **PRASIOLA.** *Ag.* (1821.)

Thallus membranaceous foliaceous, ascending or erect, more or less crispate, composed of angular cells, distributed in plane areas ; base sometimes loosely fibrillose.

Vegetation by division of the cells in two directions.

Prasiola crispa. *Kutz. Tab. Phyc. V. t.* 40, *f.* 6.

Tufts more or less dense, often long and widely expanded, dark green, soft and elastic. Thallus plicate crisped, of variable form and size, often bullate ; cells arranged in distinct areolas, or confluent, quadrate, or oblong-quadrangular, now and then twice as long as the diameter ; angles more or less obtusely rounded.

SIZE. Cells ·005-·009 mm. diam., or ·008-·013 mm. × ·003-·005 mm.

Jessen Mon. Pras. t. 1, f. 10-16. Rabh. Alg. Eur. iii, 308. Lagerstedt, Pras. p. 19.

Ulva crispa, Hass. Alg. t. 78, f. 12. Eng. Flora v., p. 312. Eng. Bot. ed. i, 2754 ; ed. ii, 2406. Lightf. Fl. Scot. 972. Harv. Man. 171. Grev. Fl. Edin. 299. Hook Fl. Scot. ii., 91. Mack. Fl. Hib. 243. Hull Br. Fl. 309. Abbot. Fl. Bedf. 273. Johnst. Fl. Berw. ii., 250. Jenner. Tunb. Wells 190.

Ulva lactuca γ, Huds. Fl. Ang. p. 567. Dillen. Musc. t. 9, f. 6.

Ulva terrestris, Gray. Arr. i., 344.

Tremella crispa, With. Arr. iv., 81.

On damp ground, rocks, &c.

Hassall unites this species and the next together in one, but his example has not been followed by his successors.

Common on moist shady ground, especially near houses and walls, sometimes on old thatched roofs. Fronds very much crowded, forming a dense stratum, rather lying on the soil or medium than attached to it ; deep green, rounded, thin, tender, but not gelatinous, variously curled and folded. Quaternate granules beautifully arranged in squares, contained in larger ones, and separated by parallel pellucid lines, the whole compared by Agardh to the walks and parterres of a garden. Annual. Found throughout the winter and early spring.—*Eng. Bot. p.* 111.

Plate L. fig. 1. Plants slightly magnified. Fig. 2, portion of a frond × 400.

Prasiola furfuracea. *Menegh. Cenni. p.* 36.

Forming a furfuraceous stratum, more or less expanded, dark green. Thallus about a line long and broad, dilated from the short stem-like base into a fan-like lamina; margin slightly undulate and repand, often emarginate at the apex or lobed. Cells angular, arranged in regular quadrate, or almost quadrate areolas.

Size. Cells ·014-·016 × ·004-·006 mm.

Jessen, Mon. Pras. t. 2, f. 1-10. Rabh. Alg. Eur. iii., 309. Lagerstedt Pras. p. 32.

Ulva furfuracea, Grev. Sc. Crypt. Fl. t. 265. Eng. Fl. v., p. 312. Harv. Man. 171. Eng. Bot. ed. ii., p. 112. Grev. Alg. Britt. 176, t. 18. Mack. Fl. Hib. 244.

On damp walls and rocks.

"Fronds closely tufted, forming a vivid green stratum, a yard or more in extent, two or three lines in length, erect, obovate, truncated, and usually eroded at the top, tapering at the base into a longish claw; margin inflected, substance firm, and void of lubricity. Cells in fours. It does not adhere to paper."—*Carm.*

Plate L. fig. 5. Fronds slightly magnified. Fig. 6, young frond × 400. Fig. 7, lower portion of mature frond × 400.

Prasiola stipitata. *Suhr. in Jessen Mon. t.* 2, *f.* 11-16.

Stratum cæspitose, expanded, dark green. Thallus of variable form and size, commonly one to two lines, rarely four lines long; dilated upwards from a stem-like base (lanceolate, obovate, obcordate, reniform, flabelliform, &c.), often truncate at the apex; margin slightly repand; cells in the stem-like base in series, in the upper part disposed in small regular areolas.

Size. Cells ·005-·007 mm.

Jessen, Prasiola p. 16, t. 2. Rabh. Alg. Eur. iii., 309. Lagerstedt. Pras. p. 36, fig. 4.

On rocks by the sea, &c.

Jessen, in his monograph of this genus, gives figures of the fronds of some Irish specimens of the above species, which he had seen and examined. It is, on the faith of this, included here, although it appears to be the most marine of any of the four.

Plate L. figs. 8. 9. Fronds of *P. stipitata* magnified 4 diam. Fig. 10, young frond × 400. Fig. 11, part of mature frond × 400. All after Jessen.

Prasiola calophylla. *(Spreng.) Menegh. Cenni. p.* 36.

Cæspitose, dark green, crispate; thallus 2-4 lines long, narrow, linear, rather circinate, attenuated at the base into a stem, truncate at the apex, now and then crenate; cells large, arranged in longitudinal series.

SIZE. Cells ·004-·005 × ·002-·004 mm.

Jessen, Mon. Pras. t. 1, f. 1-3. Lagerstedt. Pras. p. 40.

Ulva calophylla, Hass. Alg. 298, t. 77, f. 1. Eng. Fl. v., 312. Grev. Alg. Britt. p. 176. Eng. Bot. ed. ii., p. 112. Harv. Man. 171. Johnst. Fl. Berw. ii., 251. Mack. Hib. 243.

Bangia calophylla, Carm. in Grev. S. Crypt. Fl. t. 220.

On damp stones, rocks, &c.

"Forms a bright green thin stratum. Frond minute, three or four lines long, linear strap-shaped, obtuse, tapering at the base, or suddenly contracted into a cylindrical stipes, much waved and curled, very variable in breadth. Granules quaternate, closely covering the frond; set in longitudinal rows, of which two or more (sometimes half a dozen) form the breadth of the frond; interstices colourless."—*Harvey.*

Plate L. fig. 3. Plant magnified slightly. Fig. 4, lower portion of frond × 400.

Sub-Family 2. ULVEÆ.

Thallus membranaceous, vesiculose, or tubulose.

GENUS 55. **ENTEROMORPHA.** *Link.* (1820.)

Thallus membranaceous, tubular or utricle-shaped, fixed at the base (usually at the first, but afterwards often free swimming); composed of one stratum of cells, sometimes branched, but rarely much branched.

Propagation by zoogonidia, produced by repeated division of the cytioplasm, rostrate at one extremity, and furnished with two cilia.

Enteromorpha intestinalis. *(Linn.) Link. Hor. Ber.* (1820.)

Fronds simple, elongated, variable in form and size, usually becoming more or less inflated, obtuse above, attenuated at the base, pale green; cells 3-5-6 angled.

SIZE. Cells ·012-·02 mm. diam.

Eng. Fl. v., p. 314. Jenner, Tunb. Wells 190. Eng. Bot., ed. ii., t. 2408. Hass. Alg. 303, t. 77, f. 2. Grev. Alg. Britt. 179. Harv. Man. 173. Mack. Fl. Hib. 242. Wyatt. Alg. Exs., No. 80. Rabh. Alg. Eur. iii., 312.

Ulva marina tubulosa intestinorum figuram. Ray. Syn., 62.

Tremella marina tubulosa, etc. Dillen. Musc., t. 9, f. 7.

Ulva intestinalis. Huds. Angl. 568. Light. Fl. Scot. 968. Relh. Cant. 443. Purt. Midl. Fl. ii., 617. Hook. Fl.

Scot. ii., 91. Johnst. Fl. Berw. ii., 249. Hull, Br. Fl. 311. Abbot Fl. Bedf. 273. With. Arr. iv., 125.

Scytosiphon intestinalis. Gray, Arr. i., 345.

Enteromorpha lacustris. Hass. Trans. Linn. Soc.

Fistularia intestinalis. Grev. Fl. Edin. 300. Fl. Devon. ii., 57.

In ditches, chiefly in brackish water.

This exceedingly variable species has many forms or varieties to which names have been given, one of which by rupture of the apex, is funnel-shaped (var. *Cornucopiæ*), others are more or less thread-like, and others inflated and bullate. Root a minute scutate disc. Frond from a few inches to one or more feet in length, and from a line to three or four inches, or more, in diameter; tubular, obtuse, tapering at base to little more than the diameter of hog's bristle, gradually becoming inflated upwards, and in old age often swelling out into a large membranous bag, which is variously cusped and curled. Sometimes the whole frond is compressed and very much crisped; substance thin and membranous, but not gelatinous, not closely adhering to paper in drying. Colour varying from a transparent yellowish green to a dull grass green; in old age and decay fading to a dirty white. Under the microscope a portion of the frond exhibits the appearance of a transparent membrane covered with green unequal angular cells.—*Harvey*.

It occurs on the sea shore, in tidal rivers, and ditches connected with them, whether salt, brackish, or fresh water, sometimes at a considerable distance from the sea. In this respect it differs from *Enteromorpha compressa*, which is *not* found in fresh water, and has therefore no claim to be inserted in the present work.

Plate LI. figs. 1, 2. Small fronds of *Ent. intestinalis*, natural size. Fig. 3, the variety *Cornucopiæ*, nat. size. Fig. 4, cells × 400. Fig. 5, zoogonidia.

GENUS 56. **MONOSTROMA.** *Thur.* (1854.)

Frond plane or saccate, simple or torn and lobate, composed of one stratum of cells, cells somewhat rounded (sometimes quaternate) immersed in a homogenous membrane.—*Thuret, Note sur la synonymie des Ulva, &c.*

This genus was formerly included in *Ulva*, from which it was separated by Thuret. See also Monograph of *Monostroma*, by Prof. V. Wittrock. The majority of species are marine.

Monostroma laceratum. *Thur. Note sur Ulv.*

Thallus membranaceous, at length free, thin and flaccid, pallid green, of irregular form, rugose, margin plane and eroded, or crisped (·04-·05 mm. thick); cells rounded, twin, ternate, or quaternate, disposed loosely in the intercellular substance, in transverse section of the thallus oval (·017-·023 mm. high), chlorophyllose body central, of the same form as the cell, of which it occupies about one-half.—*Wittr. Mon. Monostr.*, p. 30, *t.* 1, *f.* 2.

Plate LI., fig. 6. Portion of frond × 200. Fig. 7, section of frond × 200 diam.

Monostroma Wittrockii. *Born. Notes Alg. p.* 176.

Thallus membranaceous, gelatinous, bright green (18 mill.) oblong, pedicellate, at first saccate, then open at the summit, margin becoming irregularly lobed. The adult plant becomes sessile, and is attached by a part of its surface, when mature the fronds are large (8 cent. diam.), the lobes plicate, elongated and rounded, cell angular, subquaternate, in section of thallus rounded, chlorophyllose body occupying about half the cell.

In salt or brackish water.

Perhaps hardly claiming a place in this work, as it is more truly a marine species.

Plate LI., fig. 8. Portion of a frond × 200. Fig. 9, 10, sections of frond × 200. Fig. 11, zoogonidia × 300. Fig. 12, germinating × 200, after Bornet.

Monostroma bullosum. Wittr. Mon., p. 28, is the *Tetraspora bullosa* of this work, see *p.* 16, *plate* VI., *fig.* 1.

Family II. SPHÆROPLEACEÆ.

Threads simple, with terminal vegetation, very long, articulate, articulations cylindrical, by spurious septa multilocular. Chlorophyllose mass distributed in annular bands, which enclose from 3-7 starch vesicles.

Propagation by oospores after sexual fecundation, very numerous in the cells, at first green, then red, enclosed in a stellate sporoderm.

Genus 57. **SPHÆROPLEA.** *Ag.* (1824.)

Characters the same as given above for the family, which consists but of one genus.

The following is an abstract of a memoir on *Sphæroplea annulina,* by Cohn (in the "Ann. des Sci. Nat.," 1856, p. 187), describing the process of fructification :—"The structure of the resting-spores is very singular. They are red spherical bodies, from one 120th to one 100th of a line in diameter, and formed of two hyaline membranes, the interior of which is intimately connected with its plastic contents, whilst the exterior is loose and elegantly plaited. These plaits or folds are so arranged that they meet at their two poles; often, however, they are very irregular in shape and direction, especially in the larger spores.

"In germination the resting-spores undergo several modifications. They become granular and change to a dull brown red, and a more transparent circle appears in their centre. Frequently the red matter changes to green before the germination, and this change of colour is gradual, proceeding from the circumference to the centre of the cavity. At length the whole of the plastic contents divides into two, then into four or eight bodies, which burst the double envelope and disperse in the water as so many zoospores.

"The zoospores are of an elegant shape, but this is not more uniform than their size or colour. Usually they are globular or shortly cylindrical bodies, from one 190th to one 150th of a line long, of a beautiful cinnabar or carmine red, and furnished at one of their ends with a small colourless bead bearing two long cilia. Some of them are larger, pyriform or fusiform, and the result probably of the undivided contents of a resting-spore. Some of the zoospores are two-coloured —red towards the beak, and green throughout the other part, or the two colours are variously disposed, the colourless bead or beak, and the two cilia are invariably very distinct. The zoospores exhibit a slow jerking movement during several hours. This movement is often interrupted for several hours, when the whirling suddenly recommences. When the zoospores break through the integument within which they are formed, they are not enveloped in cellulose, but already during their period of activity they begin to invest themselves with a thin elastic pellicle. At the time of their germination this envelope thickens and lengthens in the form of a spindle, the two ends soon tapering off into long tails, which even the enlarging body of the zoospore itself separates farther and farther apart. The contents of this germ-cell, at first homogeneous and finally granular, change during this first growth. What is left of the red oil is quickly transformed into chlorophyll, and the plantlet assumes a uniform green colour. Nevertheless one may perceive from the beginning a number of vacuoles, or limpid, colourless droplets, in the midst of the protoplasm with which they are filled, and between them the chlorophyll collects in rings more or less distinct from each other. Soon large grains of starch appear in these collections of green matter, so that the plantlet combines all the characteristics of an adult cellule of the *Sphæroplea*, even before it has exceeded a 13th of a line in length. The terminal tails have been observed after the plantlet was more than half a line long. Growth takes place in the middle, by the successive division of the older rings. The contents of the adult threads presents the most beautiful appearances. It consists of a colourless protoplasm, a green chlorophyll, a watery liquid, and granules of starch; the whole so disposed that the liquid element forms large vacuoles in a row, like the pearls of a necklet, and the diameter of which is nearly as great as that of the thread itself. Often these vacuoles abut on each other, and seem to give birth to partitions. In the spaces between the pairs of vacuoles the green plasma and grains of starch crowd together, though the space is disjointed by the innumerable small vacuoles they throw off.

"On approaching fructification the vacuoles multiply to such an extent as to give the endochrome the appearance of a frothy mass, in which the starch granules are irregularly scattered. Soon after the starch granules assemble in pairs or threes or larger numbers, and around these groups the green plasma becomes more plentiful, so that in time they appear as so many equidistant cysts in the axis of the thread. The greater part of the vacuoles having gradually disappeared, the green clots assume a stellate appearance, connected by green mucous rays or filaments. Between these star-like clots large vacuoles are formed in pairs, which flatten so as to look like partitions, so that each thread seems to be divided into numerous compartments.

"The green matter contained in these compartments then undergoes modifications, and the mucous rays are gradually resorbed, the chlorophyll contracting meanwhile—sometimes to the right and sometimes to the left. In a short time the colourless plasm collects around the chlorophyll in such a manner that the partitions disappear, and the whole contents of the thread breaks up into a large number of free globular masses, easily distinguished from the ambient colourless mucilage, and containing a certain quantity of irregularly distributed chlorophyll. These are the young spores, which undergo a marvellous variety of transformations. At first they are contiguous, but as they contract they become free, though variable in shape, and with their chlorophyll distributed in a thousand different ways. Finally they become spherical and almost completely filled with chlorophyll interspersed with some starch granules, and covered with a thin, smooth layer of plastic matter, but not with a cellulose membrane.

"Long before the foregoing process has taken place, the cell-wall proper of the thread has undergone some peculiar chemical alterations, all tending to its final dissolution to free the fully-developed spores. Previous to this, however, little apertures are formed in it at certain points, varying in diameter from one 500th to one 300th of a line.

"All the cellules of the same filament do not undergo the modifications described. In a large number of them the phenomena are quite different, the green rings, interspersed with colourless vacuoles, gradually change to a reddish yellow, and the grains of starch disappear. Soon the coloured matter thus formed becomes granular, and is finally broken up into innumerable rod-like corpuscles."

Thus the cycle is completed, and we need not pursue the abstract further. *Plate LII.* will serve to illustrate the various changes.

Sphæroplea annulina. (*Roth.*) *Ag. Syst. p.* 76.

Green, yellowish, brick-red, or scarlet, cells 8 to 10 or 20 times as long as broad, with 20 to 30 chlorophyllose rings in each cell; spores at length densely seriate, rarely disposed irregularly, at first green, afterwards olive-brown, and then red.

SIZE. Threads ·036-·07 mm. diam., oospore ·018-·036 mm.

Rabh. Alg. Eur. iii., p. 318. Rabh. Alg. ex. 309, 455, 147. Cohn, in Acad. Berl. 1855, p. 335. Ann. des. Sci. Nat. 4 ser. (1856) v., t. 12-13. Cienkowski, Bot. Zeit. (1855), p. 777. Fresenius Bot. Zeit (1851), p. 241. Braun, Rejuvenescence p. 164, 271, 281.

Conferva annulina, Roth. Cat. iii., p. 7.

In quarries, pits, or inundated fields.

Cohn has remarked that whereas most confervoid Algæ vegetate by repeated subdivision of the terminal cell, being at some time or other attached by the base, the present has both extremities alike, and neither of them rooting, moreover the vegetation is carried on by sub-division of the central cells, so that the terminal cells remain the oldest.

Plate LII. fig. 1. Portion of filament of *Sphæroplea annulina* with the green cytioplasm in rings × 400. Fig. 2, cells showing the formation of spermatozoids × 400 with escaped spermatozoids *s* below. Fig. 3, spores having acquired a globose form being fertilized by spermatozoids. Fig. 5, spores in an earlier stage. Fig. 8, isolated spore with spermatozoid attached. Fig. 6, mature spores, having acquired an orange colour and stellate outline, the primary membrane is detached × 400. Fig. 7, cells showing arrangement of mature spores × 300. Fig. 4, resting spore in various stages; *a*, mature; *b*, divided into 2; *c* and *d*, further subdivided. Fig. 9, zoogonidia × 400. Fig. 10, germination of zoogonidia × 400. All except Fig. 7 after Cohn.

Family III. CONFERVACEÆ.

Threads articulate, either simple or branched, vegetation terminal, unlimited. Articulations more or less elongated, rarely abbreviated, now and then shorter than the diameter, cylindrical, rarely swollen. Cell membrane sometimes manifestly lamellose. Chlorophyllose mass granulate, containing starch granules, effused, parietal, or sometimes contracted in the centre of the cell.

Vegetation by the repeated division of the primordial utricle in one direction.

Propagation by zoogonidia.

Genus 58. **MICROSPORA.** *Thur.* (1851.)

Articulate thread simple. Chlorophyllose mass at first parietal, afterwards contracted in the centre. All articulations fertile.

Propagation by zoogonidia. Zoogonidia arising from a simultaneous division of the cell contents, small, numerous, ovate-elliptical, cuspidate and colourless at one end, usually furnished with two, rarely 3 to 4, cilia, escaping by rupture of the cell.

Microspora fugacissima. (*Ag. Syst. p* 43.)

Pale green, or yellowish green, articulations before division 4 to 5 times as long as their diameter, after division about 2 to 2½ times as long, not constricted at the joints.

Size. Cells ·0085-·01 mm. diam.

Rabh. Alg. Eur. iii., 321.

Conferva fugacissima, Grev. Fl. Ed. 317. Gray Arr. i., 310. Kirsch. Alg. Schl. p. 80.

In ditches.

Plate LIII. fig. 1. Portions of threads of *M. fugacissima* × 300 diam.

Microspora vulgaris. *Rabh. Alg. Eur.* iii., 321.

Bright green, articulations 2 to 3½ times as long as the diameter.

Size. Threads ·012 mm. diameter.

Conferva bombycina inæqualis, Kutz. Tab. iii., t. 44, f. 3.

Microspora bombycina, Thuret. Rech. p. 12.

Conferva vulgaris, Kirsch. Alg. Schl. p. 79.

In ditches and pools.

Plate LIII. fig 2. Portions of threads of *M. vulgaris* × 300 diam.

Microspora floccosa. (*Ag.*) *Thuret. Rech. t.* 17, *f.* 4-7.

Articulations before division about twice as long as the diameter, after division about equal, or a little shorter, slightly constricted at the joints.

SIZE. Threads ·015-·017 mm. diam. (according to Kirschner ·0075-·01 mm. diam.).

Rabh. Alg. Eur. iii., 321. Thuret. Ann. Sci. Nat. 1850, t. 17, f. 4-5.

Conferva floccosa, Ag. Syst. p. 89. Kutz. Tab. iii., t. 43. f. 3. Eng. Fl. v., 351. Eng. Bot. ii., t. 2474. Harv. Man. 126. Mack. Hib. 224. Gray Arr. i., 310. Kirsch. Alg. Schl. p. 79.

Lyngbya floccosa, Hass. Alg. 223, t. 60, f. 1-2. Jenner, Tunb. Wells, 188.

Conferva fugacissima, Dill. Conf. Supp. t. B.

In stagnant water.

Plate LIII. fig. 3. *a, b,* portions of threads × 300; *c,* cells divided across for the escape of zoogonidia × 300; *d,* zoogonidia.

GENUS 59. **CONFERVA.** (*Linn.*) *Link.* (1820.)

Articulate threads simple, articulations cylindrical. Chlorophyllose mass homogeneous or granulate, including starch granules.

Vegetation by division in one direction.

Propagation unknown, (? by resting-spores which subsequently produce zoogonidia).

Recently Wille has declared his belief in the universality of resting-spores in the whole genus *Conferva,** although it is hardly clear what is his conception of the limits of the genus. In a new species which he has described under the name of *Conferva Wittrockii*, he gives detailed account of spore formation, which it is presumed may be accepted as a type of what usually takes place.

"The chlorophyllaceous contents contract, and become rounded. The colouring matter collects principally in the ends of the cells, so that the substance in the middle appears almost colourless; but after the contraction of the cell contents the chlorophyllaceous portions of the protoplasm draw nearer together, until at last they coalesce and form a round or elliptical body within the mother cell; they then begin to surround themselves with a membrane, which later consists of two distinct layers. The spores are generally set free by the filaments resolving themselves into H shaped cells (in which the cell wall of each cell has a transverse fissure in the middle of the transverse walls); the spores then fall out. Sometimes they escape by the cell walls becoming converted into mucilage, their layers becoming gradually indistinguishable. On first germinating, the size of the spores increases, as the result of which the outer membrane bursts. The outer membrane consists of two pieces with pointed ends, one being much larger than the

* Ofversigt af Kon. Vetensk Akad Forhandl. xxxviii (1881). "Journal of Royal Microscopical Society," Dec., 1882, p. 836.

other, and covering it like the lid of a box. Afterwards, through the expansion of the inner membrane, the smaller piece of the outer membrane gives way, and the inner membrane grows through the aperture thus formed in the form of a tube. The development was not followed further, but the writer considers it probable that zoospores are first formed from the resting spores."

In *Conferva bombycina*, var. *minor*, either single cells swell up into a barrel shape, or here and there the contiguous ends of two neighbouring cells assume a club-like form. It is here that the largest part of the Chlorophyllaceous protoplasm accumulates, and after this the swollen end is separated by a transverse wall from the longer narrow part of the mother-cell. The wall of the swollen part thickens later. The author considers these cells to be resting-spores, although he was not able to observe their germination. *Conferva bombycina* var. *genuina* has similar resting-spores.

Three modes of formation of resting-spores of *Confervaceæ* have been observed—(1) by rejuvenescence, and the formation of a new membrane round the contracting contents; (2) by the thickening of the membrane of the mother-cell; (3) by separation of a portion of the cell substance to a swollen part of the mother-cell, and the thickening of the membrane of this portion.

Conferva fontinalis. *Berk. Glean. t.* 14, *f.* I.

Bright green, attached; articulations 6 to 10 times as long as the diameter, slightly swollen, a little constricted at the joints, starch granules single, scattered or seriate, cell-membrane rather thick, homogeneous, when heated with sulphuric acid swelling and distinctly lamellose.

SIZE. Threads ·016-·018 mm. diam.

Kutz. Tab. iii., t. 45, f. 4. Rabh. Alg. Eur. iii., 323. Kirsch. Alg. Schl. p. 78.

Attached to grass, &c., in ditches.

"It covers rushes, grass, &c., with a short downy green coat, which is very conspicuous in spring and summer."—*Berkeley.*

Plate LIII. fig. 6. Threads of *C. fontinalis* × 150. Fig. 7, portions of threads × 400.

Conferva tenerrima. *Kutz. Tab.* III., *t.* 42, *f.* I.

Usually pale green, articulations 1½-3 times as long as the diameter.

SIZE. Threads ·0035-·004 mm. diam. (·003-·005 mm. Kirschner).

Rabh. Alg. Eur. iii., 322. Kirsch. Alg. Schl. p. 78.

In fresh water, often mixed with other Algæ.

Plate LIII., fig, 5. Portions of threads of *C. tenerrima* × 400.

Conferva bombycina. *Ag. Syst. p.* 83.

Yellowish green or green, soft, silky; articulations oblong-cylindrical, slightly constricted at the joints, before division three times as long as the diameter, collapsing alternately when dry.

Size. Threads ·006-·012 mm. diam.

Rabh. Alg. Eur. iii., 323. Kutz. Tab. iii., t. 44, f. 1, 2. Eng. Fl. v., p. 351. Eng. Bot. ii., p. 159. Harv. Man. 126. Mack. Hib. 224. Kirsch. Alg. Schl. p. 79.

Conferva sordida, Dillw. Conf., t. 60. Johnst. Fl. Berw. ii., 254. Eng. Bot. i., t. 2303. Grev. Fl. Ed. 317. Gray Arr. i., 310.

Vesiculifera bombycina, Jenner Fl. Tunb. Wells, 186.

In ditches, pools, &c., common.

Plate LIII. fig. 4. Portions of threads of *C. bombycina* × 400.

Genus 60. **CHÆTOMORPHA.** *Kutz.* (1845.)

Articulate thread simple, nearly equally thick, fixed by a discoid, or root-like divided base, lower articulations always short, before division equal, or half as long again as the diameter, after division shorter than the diameter, upper articulations more or less elongated. Cell-membrane thick, firm, sub-cartilaginous, manifestly lamellose. Cell contents green, becoming by age parietal, continuous, finely granulate, containing a few starch granules.

Propagation by zoogonidia.

Chiefly marine, a few in brackish water.

The lamination of the cell walls in this genus, and in *Cladophora*, appeared to Braun to present some analogy to the rings in vascular stems. He says, "The great number of layers which may be distinguished by suitable treatment in the cell membrane, even of plants of short life (*Cladophora*, *Botrydium*, &c.), is not opposed to the assumption that they are *diurnal layers*, and it is imaginable, under this hypothesis, that bright and dull days, as well as the age of the cell, and other circumstances, may effect important modifications in reference to the formation of distinguishable layers."

Chætomorpha litorea. (*Harv.*)

Rigid, green, crispate ; articulations before division one and a-half times as long as the diameter, here and there swollen in pairs and discoloured.

Size. Threads ·16 mm. diam.

Rabh. Alg. Eur. iii., 327.

Conferva litorea, Harv. Man. p. 208. Phyc. Britt., t. 333.

Conferva linum, Harv. in Eng. Fl. v., 352. Wyatt, Alg. Danm., No. 220.

In salt water ditches, and estuaries.

"Filaments 3-4 inches long or more, loosely bundled together in prostrate or floating strata of considerable extent, and of a pale green colour, becoming darker and duller as the season advances. Each filament is irregularly curled and twisted, and sometimes angularly bent. The articulations are cylindrical, filled with a pale green watery endochrome, and about once and a-half as long as broad, and here and there, at irregular intervals, two proximate articulations, longer and broader than the rest, form together a spindle-shaped swelling, in which a dark-coloured endochrome collects, the mass being darkest and densest where the two cells touch each other. This looks like the commencement of fructification, but I am unable to say whether a sporangium is ultimately formed. These dark-coloured double cells are frequently so numerous that they give the filaments, when examined with a pocket lens, a variegated appearance. Substance membranaceous, and in drying the plant scarcely adheres to paper."—*Harvey.*

Plate LIV. fig. 1. Portion of thread of *Chætomorpha litorea* × 100 diam.

Chætomorpha linum. (*Roth.*) *Kutz. Tab.* III., *t.* 55, *f.* 3.

Rather rigid, dark green, or now and then yellowish green and less rigid, lower articulations equal or almost equal in length to their diameter, upper articulations, before division, two or three times as long as the diameter, or even four times, here and there swollen. Cell-membrane of the lower articulations thick, distinctly lamellose, the upper ones thinner and indistinctly lamellose, contracted at the joints.

SIZE. Threads ·25 mm. thick.

Rabh. Alg. Eur. iii., 327. Harv. Phyc. Britt., t. 150, f. A.

Conferva linum, Ag. Syst. 97. Eng. Bot. ii., t. 2363.

Conferva capillaris, Huds. Fl. Ang., p. 598. Lightf. Fl. Scot. 988. Dillw. Conf., t. 9.

Conferva crassa, Eng. Fl. v., 252. Mack. Fl. Heb. 225.

In brackish and salt water.

"Filaments from a few inches to several feet in length, twice as thick as a hog's bristle, very much curled, rigid, crisp, and brittle, soon becoming flaccid if exposed to the air; lying in thick but not dense bundles, of considerable length, disposed in strata, one above the other. Articulations about as long as broad, filled with granular fluid, which in some joints is more dense than in others. Eventually the joints divide in the centre by a transverse line, and the mass separates, a new diaphragm is then gradually formed, and finally a new joint. This species varies much in colour, being sometimes of a pale, at other times a dark green, and is very often mottled with dark and light green. Substance rigid-membraneous, scarcely adhering to paper in drying."—*Harvey.*

Plate LIV. fig. 2. Portion of sterile thread of *Chætomorpha linum* × 100. Fig. 3, portion of fertile thread with zoogonidia × 100. Fig. 4, zoogonidia × 300.

Chætomorpha sutoria. (*Berk.*)

Dark green, crispate, rather rigid, interwoven in lax tufts, articulations one and a-half times as long as broad, after division shorter than the diameter, cell-membrane thick, distinctly lamellose.

SIZE. Threads ·01-·012 mm. diam.

Conferva sutoria, Berk. Glean., t. 14, f. 3. Harv. Man. 128. Phyc. Britt., t. 150, f. B.

In brackish ditches, estuaries, and salt water.

"Filaments several inches to a foot or more in length, as thick as hog's bristle, variously curved and twisted, forming extensive, loosely packed bundles or strata which fill the pools in which they grow. Articulations once and a-half as long as broad, filled with a dark green fluid, at length separating by a transverse medial line into two portions, which eventually become separate joints. Colour dark green, not variegated. Substance rigid, not adhering to paper in drying."—*Harvey.*

Plate LIV. fig. 5. Portion of base of thread of *Chætomorpha sutoria* × 100.

Chætomorpha implexa. (*Dell.*) *Kutz. Tab.* III., *t.* 51, *f.* 3.

Pale or deep yellowish green, crispate, interwoven in lax tufts, rather rigid, sometimes mucous, articulations before division twice as long as the diameter ; cell-membrane rather thick, indistinctly lamellose, after application of concentrated sulphuric acid at first homogeneous, but after four hours' action manifestly striate-lamellose.

SIZE. Threads, ·04-·06 mm. diam.

Rabh. Alg. Eur. iii., 329.

Conferva implexa, Dillw. Conf., t. B. Ag. Syst. p. 91.

Conferva sutoria, Crouan, Fl. Fin.

In brackish and salt water.

"Filaments forming densely interwoven strata, or tufts among the branches of other Algæ. Joints even in the same thread varying from a little shorter than their breadth to about once and a-half as long. Colour a dark grass green."—*Harvey.*

Plate LIV. fig. 6. Portions of threads of *Chætomorpha implexa* × 200.

GENUS 61. **RHIZOCLONIUM.** *Kutz.* (1843.)

Articulate thread the same as in *Conferva,* but distinctly contorted, and forming by prolification of the cells short root-like processes.

Propagation unknown.

Rhizoclonium Casparyi. *Harv. Phy. Britt., t.* 354, B.

Filaments elongated, slender, decumbent, pale yellow green, stratified, interwoven, curved here and there, and angularly bent, at the angles emitting short root-like branches, which sometimes lengthen, and are filled with endochrome; articulations 2 to 6 times longer than broad, with narrow dissepiments and granular endochrome.

SIZE. Threads ·018-·025 mm.

Rabh. Alg. Eur. iii., 330.

In brackish and salt water.

"Forming a thin web of a bright green colour and considerable extent. Filaments elongate, gracefully curved rather than twisted, interwoven, here and there angularly bent. At the angle issues a root-like process, which sometimes consists of but a few empty cells, at other times lengthens out into a branch. Cells in the same fleece very various, and even in the same filament at different ages ; the full-grown cell seems to be fully six times as long as its diameter; but short cells once and a-half to twice as long as broad, which seem to be cells in process of development, are commonly mixed with the long cells. All contain a granular endochrome, the grains of very unequal size."—*Harvey.*

Plate LIV. fig. 7. Portions of thread of *Rhizoclonium Casparyi* × 200 diam.

Rhizoclonium flavicans. *Jurg. Alg.*

Threads soft, simple, extremely fine, matted, somewhat crisped, at first uniform pale green, at length distinctly jointed ; articulations once and a-half as long as broad, dotted; interstices pellucid.

SIZE. Threads ·018 mm. diam.

Rabh. Alg. Eur. iii., 331.

Conferva arenicola, Berk. Glean, t. 13, f. 3. Harv. Man. 128. Harv. Phyc. Britt., t. 354 A.

At the mouths of rivers, and salt marshes.

" Creeping on the sandy margin of pools in a salt marsh periodically flooded, forming a thin, soft, delicate, crisped web of a pale yellow green. Threads extremely slender, flexuous, at first self-coloured, with a few scattered dots, then with manifest dissepiments, and finally the granules contract and form a distinctly defined mass of a darker green in the centre, with pellucid interstices. Articulations one and a half times as long as broad. When dry the articulations are alternately contracted."—*Berkeley.*

Plate LIV. fig. 8. Portions of threads of *Rhizocloninm flavicans* × 200 diam.

GENUS 62. **CLADOPHORA.** *Kutz.* (1843.)

Articulate thread variously branched, cell-membrane usually thick, lamellose; cell contents parietal.

Propagation by zoogonidia, arising from simultaneous and multipartite division of the cell contents, moving actively within the mother-cell, afterwards escaping by a lateral or terminal opening, furnished with 2 or 4 vibratile cilia, afterwards germinating without fecundation.

Many species are entirely marine, but some are fresh water. All are disposed to considerable variation, and numerous varieties are named in connection with each of the fresh water species. The following arrangement of the species from Rabenhorst's Algæ will be useful in their identification :—

I. Threads collected in tufts, more or less lax or intricate.
  A. Tufts at first attached, afterwards free swimming.
    a. Cell contents not spirally disposed.
      † Fruiting cells not terminal.
        * Cell-membrane even . . . . *fracta.*
        ** Cell-membrane plicato-striate . . *crispata.*

B. Tufts for the whole life attached.
a. Cell contents disposed in lax spirals.
† Fruiting cells terminal or subterminal.
* Cell-membrane even.
0. Branches connate at the base . . . . *canalicularis.*
00. Branches not connate at the base . . . . . *glomerata.*
** Cell-membrane plicate . . . . *flavescens.*
II. Threads radiating from a common centre, aggregated in a more or less spongy globe . . . . *ægagropila.*

Cladophora fracta. (*Dillw.*) *Kutz. Sp. Alg., p.* 410.

Branches and branchlets sparse, divaricate, here and there refracted, often secund, the lower laterally inserted. Cell contents of the branches not spirally arranged, cell-membrane now and then very thick. Fructiferous cells not terminal, often in the middle of the branches or at their base.

SIZE. Threads ·1 mm. diam.

Kutz. Tab. iii., t. 50. Rabh. Alg. Eur. iii., 334. Jenner Fl. Tunb. Wells 186. Harv. Man. 134.

Conferva fracta, Eng. Fl. v. 356. Johns. Fl. Berw. ii., 254. Eng. Bot. i., t. 2338, ii., t. 2492. Dillw. Conf., t. 14. Lyngb. Hydr. Dan. t., 52. Grev. Fl. Ed. 318. Hook. Fl. Scot. ii., 82. Mack Hib. 227. Fl. Devon ii., 52. Gray Arr. i., 304.

Conferva vagabunda, Huds. Fl. Ang. ii., 601. Lightf. Fl. Scot. 990. With Arr. iv., 139.

Conferva marina trichoides, lanæ instar expansa, Ray. Syn. 60. Dillen. Musc. 30, t. 5, f. 32.

Cladophora crispata, Hass. Alg. 216.

In fresh and brackish water.

"At first forming loose tufts, which frequently become detached, and the plant is more commonly found constituting floating strata, many tufts entangled together in each floating mass. Filaments capillary from six to eight or ten inches long, much, but very irregularly branched, the branches distant, spreading at wide angles, or much divaricated, either dichotomous or alternate, the lesser branches repeatedly forked, with wide axils, and the ramuli which are few and very patent, commonly secund, sometimes alternate. Articulations three or four times as long as broad, rarely six times as long, those of the upper branches pretty uniformly thrice as long as their diameter, at first cylindrical, then becoming pyriform, and when mature elliptical, when the branches resemble strings of dark green beads. Dissepiments finally much contracted. Colour at first a pleasant grass green, becoming darker and duller as the plant advances in age. The endochrome is at first fluid, but in the full grown articulations (which are in fact changed into sporangia) it becomes distinctly granular, very dense, and of a dark colour. In drying the plant adheres to paper, but not very firmly."—*Harvey.*

Plate LV. fig. 1. Upper portion of filament of *Cladophora fracta* × 10 Fig. 2, portion, with fertile cell × 100 diam.

Cladophora crispata. (*Roth.*) *Kutz. Tab* IV., *t.* 40, *f.* 1.

Less coloured than the preceding, now and then dark green, sometimes colourless; branches and branchlets remote, sometimes secund, insertion (at least of the lower branches) apical, articulations collapsing, cell contents (at least of the upper branches) disposed in a lax spiral. Cell-membrane delicately plicate-striate.

SIZE. Primary branches ·022 mm. thick, ultimate branches less than half that diameter, main thread ·12 mm. diam.

Rabh. Alg. Eur. iii., 337.

Conferva crispata, Dillw. Conf. t. 93. Eng. Fl. v., 356. Eng. Bot. i., t. 2350. Harv. Man. 133. Gray Arr. i., 304. Eng. Bot. ii., t. 2420.

In pools.

"Filaments about a foot long, or more, densely entangled, rather tough, destitute of gloss, curled and crisped, especially when old. Articulations 4 or 5 times as long as broad ; by drying they become elliptical and compressed alternately."

Plate LV. fig. 3. Upper portion of filament of *Cladophora crispata* × 10. Fig. 4, small portion of sterile thread × 100 diam.

Cladophora glomerata. (*Linn.*) *Kutz. Tab. Phyc.* IV.

Branches in the upper part of the primary thread, and branchlets of the second and third order, usually fasciculate or penicellate. The cell contents of the larger cells applied in a net-like or somewhat spiral manner to the walls. Fructiferous cells always terminal, with the lower cells sterile.

SIZE. Primary and secondary branches to ·06 mm. diam. 3 to 6 times as long.

Rabh. Alg. Eur. iii., 339. Jenner Fl. Tunb. Wells 186.

Conferva glomerata, Linn. Eng. Fl. v., 306. Lightf Fl. Scot. 993. Dillw. Conf., t. 13. Huds. Fl. Ang. ii., 602. Eng. Bot. i., t. 2192, ii., t. 2494. Harv. Man. 134. Purt. Mid. Fl. ii., 610. Johnst. Fl. Berw. ii., 255. Grev. Fl. Ed. 318. Hook. Fl. Scot. ii., 82. Sibth. Ox. 337. Abbot. Fl. Bedf. 375. With Arr. iv., 140. Gray Arr. i., 306. Hass. Alg. 213, t. 56, 57, f. 1-2.

Conferva fontinalis ramosissima glomeratim congesta, Ray Syn. 59. Dillen. Musc. 28, t. 5, f. 31, A. B.

Microspora glomerata, Hass. Ann. Nat. Hist. xi.

In clear streams and rivulets, usually attached to stones.

"The whole plant is of a bright, shining green, very smooth, but not at all viscid or gelatinous to the touch. The principal stems are several inches long, sending out numerous capillary branches, which are variously subdivided, and terminate ultimately in ranges of little short ramuli all directed one way, which gives the plant a peculiar clustered or tuft-like aspect. Articulations at least five times longer than they are broad." —*Eng. Bot.*

Plate LVI. fig. 1. Portion of apex of thread slightly enlarged. Fig. 2, portion of branch × 100. Fig. 3, tip of branch with zoogonidia × 200 diam. Fig. 4, zoogonidia × 320.

Cladophora flavescens. *Ag. Syst. p.* 112.

Pale yellowish, six inches long, very much branched, fasciculate in a plumose manner, branches patent, ultimate branchlets often rather clavate, patent or incurved, cell-membrane often distinctly plicate, cell contents distributed in a reticulate manner.

SIZE. Diameter of branches ·07-·08 mm., 6-12 times as long.

Cladophora glomerata, v. *flavescens*, Rabh. Alg. Eur. iii., 342.

Cladophora flavida, Kutz. Sp. Alg., p. 402.

Conferva flavescens, Eng. Fl. v., p. 356. Dillw. Conf. Supp., t. E. Harv. Man. 133. Eng. Bot. i., t. 2088; ii., t. 2493; Wyatt Alg. Danm., No. 224. Mack. Hib. 227. Gray Arr. i., 304.

Conferva pinnatula, Dillw. Conf., t. 95.

In ditches or pools of brackish or fresh water.

"This species grows in continuous tufts, which, as they rise to the surface, form extensive floating strata covering the pool. Filaments slender, capillary, tangled together, irregularly branched; the main thread somewhat dichotomous, with widely spreading axils, and often bent in an angular manner first to one side then to the other; the lateral branches alternately divided, patent, with a few distant, scattered, alternate, or secund ramuli. Articulations cylindrical, many times longer than broad, filled with a pale, granular endochrome. Colour when young, a yellowish green, becoming yellower in age, and at last almost golden. When dry it has a silky appearance, and fades in the herbarium to a yellowish white. Substance soft, membranous, but not strongly adhering to paper."—*Harvey.*

Besides its pale green colour it is readily distinguished from *C. fracta* by the much longer articulations, and their less granular contents.

Plate LV. fig. 5. Upper portion of filament of *Cladophora flavescens* × 10. Fig. 6, portion of filament with fertile terminal cell × 100. Fig, 7, apex of terminal cells, with zoogonidia escaping × 200.

Cladophora canalicularis. (*Roth.*) *Kutz. Sp.* 409.

Dichotomously or trichotomously branched, branches connate at the base, often fasciculately branched above as in *C. glomerata*. Fructiferous cells terminal. Cell-membrane often thick, now and then swollen. Cell contents arranged in very lax spirals.

SIZE. Lower branches ·08-·12 mm., 4-8 times as long.

Rabh. Alg Eur. iii., 342.

Alga in tubules aquam fontanam deducentibus, Dill. Musc., t. 4, f. 15.

Conferva canalicularis, Sibth. Ox., 336. Hall Br. Fl., 331. Abbot Fl. Bedf. 274. With. Arr. iv., 129. Relb. Cant. 443. Huds. Fl. Angl. 593. Purton Midl. Fl. ii., 610.

In ditches, pools, and other standing water.

Articulations four to eight times as long as their diameter, usually bright green.

Plate LVI. fig. 5. Part of branch of *C. canalicularis* × 100 diam.

Cladophora ægagropila. (*Linn.*) *Kutz. Tab.* III.

Dark green, threads rigid, very much branched, radiating from a common centre, at length agglomerated into a very dense, spongy globe. Ramuli erect, often quite obtuse, articulations sometimes incrassated upwards, cell contents not arranged in spirals, cell-membrane now and then thickened.

SIZE. Branches ·04-·07 diam, 2-4 or even 12 times as long.

Rabh. Alg. Eur. iii., 343.

Conferva ægagropila, Linn. Dillw. Conf., t. 87. Purt. Mid. Fl. iii., p. 175. Eng. Bot. ii., 1377; ii., 2496. Harv. Man. 134. Eng. Fl. v., 357. Huds. Fl. Ang. ii., 604. Mack. Hib. 228. Hull Br. Fl. 332. Hook. Fl. Scot. ii., 82. With. Arr. iv., 141.

Conferva globosa, Phil. Trans. Roy. Soc. xli., 498.

Conferva ægagropilaris, Gray Arr. i., 308.

Cladophora glomerata, Hass. Alg., p. 213 in part.

var. **Brownii** (*Dillw.*).

Rabh. Alg. Eur. iii., 345.

Conferva Brownii, Dillw. Conf. Syn., t. D. Harv. Man. 134. Eng. Fl. v., 356. Wyatt Alg. Dan., No. 225. Mack. Fl. Hib. 228. Eng. Bot. 2879.

" This singular vegetable production is a native of Alpine lakes in many parts of Europe, often lying in great abundance at the bottom of the water, and occasionally only rising and floating on the surface. It has been found in the lakes of the north of England, Wales, Scotland, and the district of Connemara in Ireland, but is generally esteemed rare. In size it varies from that of a small pea to three or four inches in diameter, and its form is always nearly spherical. Internally the larger specimens are hollow, without any nucleus, and when examined their substance is found to consist of innumerable green, pellucid, repeatedly branched filaments, firmly entangled together. The vesicles, when the plant is recently taken from the water, are turgid with fluid, and nearly cylindrical, being slightly swollen towards the apex, where the granular matter of the endochrome seems chiefly collected as a green opaque mass; in the terminal vesicle, however, of each branch it assumes often a dark brown hue and more solidity, probably becoming the medium of reproduction, and escaping in the form of sporules. The elasticity of the balls may be estimated by the fact of their having been used as pen-wipers in the north of England.—*Eng. Bot.* 167.

Plate LVI. fig. 6. Threads of *C. ægagropila,* nat. size. Fig. 7, portion of upper branch × 100 diam.

Family IV. PITHOPHORACEÆ.

Chlorophylliferous Cladophora-like Fresh-water Algæ, consisting of cells formed by bipartition of the terminal cell, the thallus having two distinct parts—(1) the cauloid part, developed from the germinated spore upwards, propagative, and almost always branched, the branches placed a little space below the top of their supporting cells ; (2) the rhizoid part developed from the germinated spore downwards, almost always sterile and branchless, commonly unicellular. Spores neutral, quiescent (agamo-hypnospores), generally cask-shaped, single, formed by division into two of the cauloid cells, of the chlorophyll filled, and commonly widened upper parts of these cells; in germinating, as a rule, dividing into two cells, the one giving rise to the cauloid and the other to the rhizoid part of the thallus.—*Wittrock, Monograph of the Pithophoraceæ*, p. 46.

For full details of this Family, consult Prof. V. B. Wittrock "On the Development and Systematic Arrangement of the Pithophoraceæ" (published in English). Upsal, 1877.

Genus 63. **PITHOPHORA.** *Wittr.* (1877.)

Character the same as that of the family given above.

The formation of spores is effected in the following manner:—The upper part, $\frac{1}{2}$-$\frac{1}{3}$ of the mother cell of the spore, is somewhat widened. The chlorophyll-coloured protoplasm in the lower, not widened, part of the cell then passes little by little into the upper and widened part, till it is quite filled with chlorophyll-coloured protoplasm. A transversal cell wall is then little by little formed just below the point where the widened part of the cell commences. In this manner are formed one lower cell containing but little protoplasm, almost devoid of chlorophyll, the so-called subsporal cell, and one upper cell, rich in chlorophyll and reproductive, the spore. Its shape is, as a rule, cask-like or cylindrically cask-like. When the membrane of the spore has attained a not inconsiderable increase in thickness the spore reposes some time before germinating, and consequently belongs to the class of spores which is called hypnospores. With regard to its origin, it may be called an agamo-spore, as being formed neutrally without any fecundation. Formation of spores may take place in all the cells of the cauloid, in the terminal as well as in the inclosed. As a rule it begins in the youngest, *i.e.*, the terminal cells; afterwards proceeding downwards, or, in other words, basipetally, in the principal filament as well as in the branches. It is these spores which give origin by their germination to the course of development already described. In this manner you will see one neutral generation, forming hypnospores, follow upon another, in an uninterrupted series, without any metagenesis.

The reprodnction of individuals may, however, be effected also in another way than by the formation of spores. Besides the specimens which form spores, there are others which never do so. These, which are distingnished by a richer ramification, transform part of their cells into so-called "prolific cells." A common vegetative cell grows richer in chlorophyll coloured protoplasm and starch, and is thus made fit to form a new individual. This the prolific cells do, when they have been made free, by the destruction of the mother specimen, by forming a new specimen laterally near their top, in the same manner as a branch—and later a system of branches—is formed by a cell in the fertile specimens. That the specimens originated by prolific cells have the power of forming spores is certain, as well as that specimens forming prolific cells may have been originated by spores. I do not know with certainty whether specimens forming prolific cells may have been originated by prolific cells themselves, but it seems to me in no wise improbable.—*Wittrock*, l. c.

Pithophora Kewensis.—*Wittr. Mon. p.* 52.

Principal filament of the cauloid part of the thallus, in fertile specimens, on an average ·059 m. thick, with solitary branches of only one degree (rarely of two), spores single, partly enclosed, partly terminal, the enclosed spores cask-shaped, but more elongated, on an average ·08 m. thick and ·2 m. long. the terminal spores cask-shaped, with the upper end conical and the top somewhat rounded, on an average ·088 mm. thick and ·219 mm. long; the rhizoid part of the thallus as a rule unicellular.

Wittr. Mon. Pithoph. t. 1 f. 8, t. 2 f. 1-12; t. 3 f. 1-9; t. 4 f. 2-11; t. 5 f. 9 10.

In tank, Water-lily house, Kew Gardens. August.

This singular plant is thought by Wittrock to have been an importation from Brazil. It has not been seen in its original locality for two or three years.

Plate LVI. fig. 8. Portion of spore-bearing filament × 20. Fig. 9, portion of principal filament with spore formed at the apex of a short branch, and another in process of formation in the principal filament × 200. Fig. 10, a mature enclosed spore × 200. Fig. 11, part of cell from rooting portion of a sterile thread × 200. All after Wittrock.

Family V. ŒDOGONIACEÆ.

Monœcious, or diœcious algæ. Filaments articulated, either simple (*Œdogonium*) or branched (*Bulbochæte*). Basal cell obovate-clavate, mostly lobately divided, or ending in a disc.

Propagation by zoospores, or by oospores after sexual fecundation. The zoospores formed singly in certain cells, broadly oval or globose, transparent at one end, and furnished with a crown of vibratile cilia. Oogonia single or in a chain (2 to 5) contiguous to each other, more or less tumid, with a single oospore in each, becoming reddish brown or yellowish when mature, and then, before germination, dividing into (mostly 4) zoospores.

Male plants, dwarf (nannandrous) and attached to the female plants, or elongated (macrandrous) and similar to the female filaments (often rather thinner). Spermatozoids produced in abbreviated special cells (spermogonia).

Genus 64. **ŒDOGONIUM.** *Link.* (1820.)

Articulated filament simple, at first fixed, afterwards free swimming. Cells marked with transverse striæ at one or other extremity. Terminal cell sometimes elongated and setiform. Either monœcious or diœcious; when diœcious the male plants either dwarf—produced from short cells of the female plants—or elongated and independent.

Propagation by asexual zoospores, and by oospores sexually fertilized.

For details of the structure and reproduction, consult "Braun on Rejuvenescence" (Ray Society, 1853). "Pringsheim Jahrbucher" (1857). "Quarterly Journal of Microscopical Science," vi. new series, 1866, p. 149. De Bary, "Ædogonium und Bulbochæte" (1854). Juranyi in Pringsheim "Jahrbucher" (1873). Carter, in "Annals of Natural History," 3 ser. i, p. 31. Vaupell, "Jagttagelser ov. befrugt. Œdogonium" (1859). Wood, "Fresh Water Algæ of the United States" (1872). Wittrock, "Prodromus Monographiæ Œdogoniearum" (1874).

The sterile filaments of *Œdogonium* resemble those of *Conferva* at a casual glance, but are soon seen to be distinguished by transverse parallel striæ at one or other extremity of many of the cells. These striæ are indications of the mode of cell increase (Pl. LVII, fig. 5) which takes place in the following manner:—When a cell has reached maturity, and is about to divide, a little circular line is seen near its upper end. Gradually the line widens, and it is seen that the wall of the mother cell has divided all round, and the cell above is slowly raised by the growth of the daughter cell, arising, as it were, out of the apex of its parent cell, and carrying upwards the first streak or cap left by the breaking away of the wall of the mother cell. In this manner the new cell soon attains a length equal to the one from whence it sprung (the successive stages shown on Plate LVII, figs. 1 to 4). When the young cell has matured it becomes in turn a mother cell, the splitting round is repeated, a second streak or cap is carried upwards, and thus as many as four, five, or six successive cells are formed, as indicated by the four, five, or six striæ or caps which may be counted at the apex of a cell. The number of caps corresponding to the number of cells produced in this manner consecutively immediately beneath the caps.

Asexual reproduction takes place by the formation of a single zoospore in one of the cells of the filament (Plate LVII, fig. 15). It is of a globose or somewhat ovate form, furnished near its apex with vibratile cilia (fig. 14). When mature it escapes by rupture or fissure of the mother cell, moves about for awhile, then becomes attached by the ciliated end, and ultimately developes into a young plant.

Sexual reproduction is varied in three ways. In the monœcious species the oogonium is an inflated cell, more or less globose, enclosing a single oospore of similar form. The oogonium is either perforated by a pore, or splits round and opens with a lid or operculum. The same thread bears above or below the oogonium very much shortened cells, in which one or two active spermatozoids are produced. These escape when mature, and fecundate the oospore through the perforation or opening of the oogonium, after which they disappear, and the oospore ripens into a perfect, fertile, resting spore.

In the diœcious species there are two modes of sexual reproduction. In one group of species the males are dwarf, almost might be called antheridia. The oogonia and oospores are the same as in the monœcious species. In like manner there are also abbreviated cells in some other part of the same thread, but these do not produce spermatozoids, but androspores, small active ciliated bodies, which move about for a time, and then attach themselves either upon or near the oogonia, grow into the form of an inverted flask (figs. 8 to 10), being supported by a more or less elongated stem, and constitute the dwarf male (nannandrous) plants, the cells at the apex of which contain the spermatozoids, the upper cell opening by a lid, or cap, to permit of the escape of its contents, which fertilize the oospore as in the previous method.

The second group of diœcious species have male filaments, which in all respects resemble the sterile females, except that they are usually a little thinner. The female filaments produce only the oogonia. The male filaments, in certain abbreviated cells, give origin to the spermatozoids, which in due time escape and fertilize the oospores of the female plants. Thus, in the first group, the dwarf males are generated in certain privileged cells of the female plants, whilst in the second group the male and female filaments are from the first distinct. The former are called *nannandrous* species, the latter *macrandrous.*

The fertilized oospore becomes a resting spore, which ultimately passes through the following stages :—Previous to germination the spore has an egg-shaped figure; the cell contents are densely crowded, and composed of minute brownish-green granules, closely surrounded by a distinct cell-membrane. Outside this membrane there is found besides quite a distinct cell-membrane. Upon germination there are formed in both membranes slit-like openings, whereupon the cell contents emerge, surrounded by an extremely delicate hyaline covering. The cell contents are composed not of one, but usually of four green masses, each surrounded by its cell-membrane. Sometimes also as it appears, abnormally, the masses are two or three in number. The four cells which proceed from germination possess an oval form, and their cell-membrane is hyaline. After the contents of the spore have emerged there remains behind the outer membrane, enclosing the inner one. After the four cells have remained some time enclosed in the hyaline covering, this becomes resorbed subsequently, and the four cells lie still and motionless, but after the course of a short time the cells burst on one end by means of an annular slit, and the apex, separated thereby from the remainder of the cell-membrane, becomes elevated like a lid. Through the circular opening the cell contents now emerge, which at the part turned towards the opening is colourless. This apex moves with vigorous motion backwards and forwards, and after an hour the cell contents, in the form of a zoospore, leave their place of detention, which we now find to be a doubly-coloured cell-membrane. The little zoospore wheels in a lively manner about with a circling movement, whereby the colourless point becomes directed downwards. Its appearance is like that of an ordinary zoospore, and, like it, possesses an oval form and a lighter apex, furnished with cilia, which during the motion is always directed forwards. After a time the movements become faint, and finally cease. The cilia disappear, and the light end becomes elongated into a root, which sometimes becomes an organ of attachment, quite like that produced in the germination of the ordinary zoospores. The rounded end of the germinating zoospore acquires a little point-like apex. This growth becomes divided by a transverse septum, and a little two-celled Œdogonium has originated. From each spore there are thus derived, in general, four plants.

Plate LVII. figs. 1-5. Stages in the formation of new cells—after Pringsheim. Fig. 6, male cells of *Bulbochæte crassa*, with spermogonia. Fig. 7, zoospore of *Œdogonium*—after Pringsheim. Figs. 8–10, development of dwarf males—after De Bary. Fig. 11, spermogonia. Figs. 12-13, imgregnation of *Œdogonium ciliatum*—after Pringsheim. Fig. 14, zoospore of *Œdogonium rivulare.* Fig. 15, zoospore developing in its mother-cell—after Pringsheim. Fig. 16, zoospore of *Bulbochæte setigera.* Figs. 17-19, segmentation of resting spores of *Œdogonium.* Fig. 20, oospore escaping from oogonium. Fig. 21, mature oospore of *Bulbochæte* undergoing division. Fig. 22, four zoospores developed from the same. Fig. 23, sterile cells of *Œdogonium Reinschii.* All magnified 400 diam.

The following is an arrangement of British species, on the basis of Wittrock's "Monograph":—

ŒDOGONIUM.

Sect. 1. Species monœcious.

A. *Oogonia always destitute of median processes.*

a. Oospores globose or subglobose.

α Oogonia globose or subglobose.

Œ. Petri, *Wittr.*
Œ. cryptosporum, *Wittr.*
Œ. curvum, *Pringsh.*
Œ. cymatosporum, *W. & N.*
Œ. minus, *Wittr.*
Œ. vernale, *Hass.*
Œ. crispum, *Hass.*
Œ. Vaucherii, *Le Cl.*

β Oogonia elliptic or egg-shaped.

Œ. urbicum, *Wittr.*

b. Oospores ellipsoid or egg-shaped.

Œ. paludosum, *Hass.*

B. *Oogonia furnished with verticellate median processes.*

a. Oospores subglobose.

Œ. Itzigsohnii, *De By.*

b. Oospores subellipsoid.

Œ. exoisum, *Wittr. & Lund.*
Œ. Archerianum. *Cke.* (*Pringsheimianum*, Archer).

Sect. 2. Diœcious species.

Sub-Sect. 1. Species with dwarf males.

A. *Species with dwarf males unicellular.*

a. Oogonia furnished with verticellate processes in the middle.

Œ. platygynum, *Wittr.*

b. Oogonia always destitute of median processes.

α Oospores globose or subglobose.

Œ. Rothii, *Le Cl.*
Œ. Areschougii, *Wittr.*
Œ. pluviale, *Nord.*
Œ. undulatum (*Breb.*).
Œ. Reinschii, *Roy.*

β Oospores subellipsoid.

None.

B. *Species bicellular, spermogonia internal, with dwarf males.*

Œ. depressum, *Prings.*

C. *Species with dwarf males bi-multicellular, spermogonia external.*

a. Oospores even.

α Oospores globose or subglobose.

Œ. flavescens, *Hass.*
Œ. Braunii, *Kutz.*
Œ. macrandum, *Wittr.*
Œ. crassiusculum, *Wittr.*

β Oospores ellipsoid or egg-shaped.

Œ. Borisianum, *Le Cl.*
Œ. concatenatum, *Hass.*
Œ. acrosporum, *D. By.*
Œ. ciliatum, *Hass.*

b. Oospores echinulate.

α Oospores globose.

Œ. Cleveanum, *Wittr.*
Œ. echinospermum, *Br.*

β Ooospores ellipsoid.

None.

Sub-Sect. 2. Species diœcious, with elongated male plants.

a. Oospores echinulate.

None.

b. Oospores smooth.

α Oogonia not, or slightly, swollen.

Œ. capillare, *L.*

β Oogonia manifestly tumid.

αα Oospores globose or subglobose.

Œ. calcareum, *Wittr.*
Œ. cardiacum, *Hass.*
Œ. carbonicum, *Wittr.*
Œ. Pringsheimii, *Cram.*
Œ. punctato-striatum, *D. By.*

ββ Oospores ellipsoid or egg-shaped.

Œ. Boscii, *Le Cl.*
Œ. tumidulum, *Kutz.*
Œ. Landsboroughii, *Hass.*
v. gemelliparum, *Pr.*
Œ. rivulare, *Le Cl.*

Sect. 3. Species of which the organs of fructification are imperfectly known.

a. Oospores globose or subglobose.

Œ. delicatulum. *Kutz.*
Œ. tenellum. *Kutz.*
Œ. hexagonum. *Hass.*
Œ. Londinense. *Wittr.*
Œ. fasciatum. *Kutz.*
Œ. capillaceum. *Kutz.*
Œ. Hutchinsiæ. *Wittr.*
Œ. princeps. *Hass.*

b. Oospores subelliptic or oval.

Œ. longatum. *Kutz.*
Œ. vesicatum. *Lyngb.*
Œ. grande. *Kutz.*
Œ. giganteum. *Kutz.*
Œ. crassum. *Hass.*
Œ. subsetaceum. *Kutz.*

The following of Hassall's species of *Vesiculifera* have not been identified :—

Vesiculifera condensata, *Hass.* F. W. Alg. p. 196.
" Cuvieri, *Hass.* F. W. Alg. p. 198.
" Ralfsii, *Hass.* F. W. Alg. p. 199, t. 50, f. 8.
" virescens, *Hass.* F. W. Alg. p. 200, t. 50, f. 5.
" ovata, *Hass.* F. W. Alg. p. 201, t. 50, f. 6.
" dissiliens, *Hass.* F. W. Alg. p. 202, t. 50, f. 7.
" sphærica, *Hass.* F. W. Alg. p. 204, t. 53, f. 5.
" inæqualis, *Hass.* F. W. Alg. p. 205, t. 53, f. 2.
" dubia, *Hass.* F. W. Alg. p. 206, t. 53, f. 14.
" Mulleri, *Hass.* F. W. Alg. p. 207, t. 53, f. 10.
" alata, *Hass.* F. W. Alg. p. 208, t. 52, f. 9.
" affinis, *Hass.* F. W. Alg. p. 206, t. 53, f. 1.

Some of Kutzing's species, which are imperfectly described, have been mentioned as British, but we have no sufficient knowledge of them to warrant their insertion.

Section 1. Monœcious species.

A. *Oogonia always destitute of median processes.*

a. Oospores globose or subglobose.

Œdogonium Petri. *Wittr. Mon. Ædog. p.* 6.

Oogonia single, very rarely binate, pear-shaped globose, opening by a pore a little above the middle. Oospores rather depressed globose, almost filling the oogonium; spermogonia 1-2 celled, hypogynous or epigynous; spermatozoids single (?), terminal cell obtuse.

Size. Cells ·006-·007 mm., 5-7 times as long; oogonia ·021-·024 mm. × ·022-·029 mm.; oospore ·020-·23 × ·017-·019 mm.; cells of spermogonia ·0055-·006 × ·01-·011 mm.

Kirch. Alg. Schles. p. 51.

Ireland.

Having carefully measured a great number of the species here recorded, and found Wittrock's measurements universally accurate, we have given his dimensions throughout for all the species recorded by him. Unfortunately it is not easy to reduce Rabenhorst's measurements to millemetres, and equally difficult to reconcile them.

Plate LXVIII. fig. 1. *Œdogonium Petri* with oogonia × ·400.

Œdogonium cryptoporum. *Wittr. Dispos. Œd. p.* 19.

Oogonia single, elliptic, or rather depressed globose, opening by a median pore, almost filling the oogonium, spermogonia 2-7 celled, scattered. Spermatozoids single (?).

Size. Cells ·007-·009 mm. 4-6 times as long; oogonia ·024-·025 × ·026-·027 mm.; oospore ·022-·023 × ·019-·021 mm.; cells of spermogonium ·006-·008 × ·007-·011 mm.

var. β. **vulgare.** *Wittr.*

Oogonia 2-5, continuous or single, spermogonia 1-4 celled, subepigynous or hypogynous, or scattered.

Size. Cells ·005-·008 mm. 3-5 times as long; oogonia ·018-·025 × ·018-·026 mm.; oospore ·016-·022 × ·013-·018 mm.; cells of spermogonium ·005-·007 × ·009-·012 mm.

Kirch. Alg. Schles. p. 52. Wittr. Mon. p. 7.

Britain.

We have only seen the *variety*, from the West of England. The type form has not yet been found in Britain.

Plate LXVIII. fig. 2. *Œdogonium cryptoporum.* var. *vulgare* with oogonia × ·400

Œdogonium curvum. *Prings. Beitr. p 69, t. 5, f. 3.*

Oogonia 2-7 continuous, or single, depressed globose, opening by a median pore; oospores depressed globose, filling the oogonium; spermogonia 3 or many celled, situated in the upper part of the filament; spermatozoids single, the upper part of the thread arcuate, or spirally twisted.

SIZE. Cells ·005-·01 mm. $1\frac{1}{2}$-4 times as long; oogonia ·023-·025 × ·02-·024 mm.; oospore ·02-·023 × ·016-·019 mm.; cells of spermogonium ·007-·009 × ·007-·009 mm.

Wittr. Mon. Œdog p. 8. Kirch. Alg. Schles. p. 52. Rabh. Alg. Eur. iii. 350.

Ireland.

Plate LVIII. fig. 3. *Œdogonium curvum,* with oogonia and spermogonia × 400.

Œdogonium cymatosporum. *Wittr. & Nord. in Wittr. disp. Œdog. p.* 121.

Oogonia single, rarely binate, rather depressedly globose, opening by a pore at the middle, or a little above the middle, nearly filling the oogonium, membrane of the oospore-scrobiculate (undulated in a transverse section), pits deep and dense; spermogonia 1-4 celled, somewhat epigynous, hypogynous, or scattered; spermatozoids single.

SIZE. Cells ·008-·01 mm. 4-7 times as long; oogonia ·024-·034 × ·027-·036 mm.; oospore ·022-·031 × ·019-·027 mm.; cells of sperm. ·008-·009 × ·009-·015 mm.

Wittr. Mon. Œdog. p. 8.

Britain.

Plate LVIII. fig. 4. *Œdogonium cymatosporum* with oogonia. *a* oospore vertical view × 400.

Œdogonium minus. *Wittr. Mon. Œdog. p.* 9.

Oogonia single, depressedly globose, manifestly splitting round in the middle, opening by a median pore, oospores depressedly globose, nearly filling the oogonium; spermogonia 1-10 celled, subepigynous, or subhypogynous, or rarely scattered; spermatozoids single; vegetative cells slightly capitate, membrane of vegetative cells and oogonia figured with dense points spirally disposed.

SIZE. Cells ·009-·013 mm. 3-6 times as long; oogonia ·034-·046 × ·028-·042 mm.; oospore ·03-·042 × ·026-·036 mm.; cells of sperm. ·009-·012 × ·003-·005mm.

Œdog. punctato-striatum DeBary var. *minor.* Wittr. disp. Œdog. Suec p. 123. Rabh. Alg. Eur. No. 2277.

Ireland.

Plate LVIII. fig. 5. *Œdogonium minus* with oogonia × 400.

Œdogonium vernale. (*Hass*) *Wittr. Mon. Œdog. p.* 10.

Oogonia single, obversely egg-shaped or globose, opening with an operculum, fissure narrow, oospores globose, not filling the oogonium, spermogonia bicellular, sub-epigynous.

SIZE. Cells ·010-016 mm. by 4½-6 times as long; oogonia ·339-·045 × ·045-·051 mm.; oospore ·034-·038 × ·034-·039 mm.; sperm. cell ·01-·012 × ·008-·009 mm.

Vesiculifera vernalis Hass. F. W. Alg. p. 434.

Vesiculifera Candollei Hass. F. W. Alg. p. 208, t. 52, f. 9. Rabh. Alg. Eur. iii. 355.

England.

Plate LVIII. fig. 6. *Œdogonium vernale* with oogonia and spermogonia × 400.

Œdogonium crispum. (*Hass*) *Wittr. Mon. Œdog. p.* 10.

Oogonia single, obversely egg-shaped or globose, opening with an operculum, fissure narrow; oospores nearly globose, not filling the oogonium; spermogonia 2-5 celled, hypogynous, or sub-epigynous; spermatozoids binate, terminal cell obtuse.

SIZE. Cells ·012-·018 mm. 2-4½ times as long; oogonia ·037-·049 × ·042-·054 mm.; oospore ·033-·046 × ·034-·046 mm.; sperm. cell ·009-·014 × ·007-·012 mm.

Kirch. Alg. Schles. p. 52.

Versiculifera crispa, Hass. F. W. Alg. 203, t. 52, f. 8.

Œdogonium rostellatum, Prings. Beitr. p. 69, t. 5, f. 1; Archer Quart. Journ. Micr. Sci., 1867, p. 79; Rabh. Alg. Eur. iii, 347.

Œdogonium pulchellum, Braun. Rabh. Alg. Eur. 2095.

Britain and Ireland.

"This is one of several monœcious species, but it is also characterized by the oogonium not opening by a pore or aperture formed in its wall, for the admission of the spermatozoids, as is usual in this genus, but by a circumscissile dehiscence. From the cleft so produced an inner membrane projects, which seems to be itself perforate."—*Archer.*

Plate LVIII. fig. 7. *Œdogonium crispum* with oogonia × 400.

Œdogonium Vaucherii. (*Le Clerc.*) *Braun. Chytr, t.* 2, *f.* 13.

Oogonia single, obversely egg-shaped, or globose, or nearly globose, opening by a pore above the middle; oospores globose or nearly globose, not completely filling the oogonium; spermogonia 2-4 celled, sub-epigynous or hypogynous, spermatozoids binate.

SIZE. Cells ·02-·03 mm. 1½-4 times as long; oogonia ·04-·055 × ·045-·065 mm.; oospore ·035-·05 × ·035-·052 mm.; sperm. cell ·017-·024 × ·006-·011 mm.

Wittr. Mon. Œdog., p. 13. Kirch. Alg. Schles, p. 52. Rabh. Alg. Eur. iii., 349, in part.

Prolifera Vaucherii, Le Clerc sur. Prolif. 474, t. 24, f. 4 ?

Vesiculifera Vaucherii, Hassall, t 50, f. 4.

Britain.

Plate LVIII. fig. 8. *Œdogonium Vaucherii*, with oogonia and spermogonia × 400.

Œdogonium urbicum. *Wittr. Mon. Œdog. p.* 13.

Oogonia single, ellipsoid, opening by a pore above the middle, oospores globose, not filling the oogonium, spermogonia usually 2 celled, spermatozoids binate, supporting cells destitute of chlorophyll.

Size. Cells ·016 mm. by 2½, 6 times as long ; oospore ·033-·045 × ·033-·045 mm.

Kirch. Alg. Schles. p. 52.

Œdogonium tumidulum, Prings. Beitr., p. 69, t. 5, f. 2 (not Kutzing). Micr. Journ. 1866, p. 69.

Œdogonium Vaucherii, in Rabh. Alg. Eur. iii., 349, in part.

Ireland.

Plate LIX. fig. 1. *Œdogonium urbicum*, with oogonium and spermogonia × 400.

b. Oospores ellipsoid or egg-shaped.

Œdogonium paludosum. (*Hass.*) *Wittr. Mon. Œdog. p.* 14.

Oogonia single, ellipsoid, usually rather oblique, opening by a pore above the middle ; oospores ellipsoid, distinctly filling the oogonium (membrane of the oospore, when mature, longitudinally costate ?); spermogonia 1-8 celled, scattered, usually situate in the upper portion of the filament; spermatozoids binate, often born with an oblique division.

Size. Cells ·015-·02 mm. by 3-7 times as long; oogonia ·039-·048 × ·066-·084 mm. ; oospore ·036-·045 × ·054-·063 mm. ; sperm. cell ·014-·016 × ·006-·013 mm.

Vesiculifera paludosa, Hass. F. W. Alg. p. 199, t. 52, f. 3 ?

England.

Plate LIX. fig. 2. *Œdogonium paludosum* with oogonium and spermogonia × 400.

B. *Oogonia furnished with verticillate median processes.*

a. Oospores subglobose.

Œdogonium Itzigsohnii. *D'Bary Œdog. p.* 56, *t.* 3, *f.* 29-32.

Oogonia single, ellipsoid, median processes 7-10, obtusely conical, oogonia splitting round below the middle, opening by a pore in the fissure, viewed from above stellate, with 7-10 rays, the depressions between the rays deep and rounded; oospores globose, not filling the oogonium; spermogonia 1-2 celled, terminal cell obtuse or apiculate.

SIZE. Cells ·008-·01 mm. by 3-6 times as long; oogonia ·034-·038 × ·032-·04 mm.; oospore ·022-·023 × ·022-·023 mm.; sperm. cell ·008-·009 × ·009-·015 mm.

Wittr. Mon. Œdog. p. 16. Kirch. Alg. Schles. p. 53. Archer, in Quart. Journ. Micr. Sci., 1866, p. 63, Rabh. Alg. Eur. iii., 352.

Ireland, Scotland.

This minute species Mr. Archer had found several times, and often showing its peculiarly-lobed oogonium, but he had never found the male fructification; he believed the plant must turn out to be a diœcious species; he had sometimes noticed a minute notch-like depression on the upper outer margin of the oogonium, probably indicating the "micropyle." He drew attention to the character, not adverted to by De Bary, that the apical or terminal joint of the filament possessed a short acute spine or mucro. This in old plants, frequently is not to be seen, as the terminal joint, or, indeed, considerable portions of the filaments, often become detached, and chiefly in a young condition only are the plants found entire.—*Quart. Journ. l. c.*

Plate LIX. fig. 3. *Œdogonium Itzigsohnii*, with oogonia and oospores; *a*, transverse section of oospore × 400.

b. Oospores subellipsoid.

Œdogonium excisum. *Wittr. & Lund., in Wittr. Œdog. Nov. p.* 3, *t.* 1, *f.* 1-4.

Oogonia single, biconically-oblong, median processes 9, rounded, small, oogonia deeply cut round (circumscissile), vertical view orbicular, margin slightly undulated; oospores ellipsoid, as if constricted in the middle, not filling the oogonium. Spermogonia 1-2 celled, subepigynous or hypogynous, terminal cell obtuse, upper part of the filament curved.

SIZE. Cells ·0035-·005 mm. by 5-6 times as long; Oogonia ·013-·015 × ·018-·025 mm.; oospore ·009-·012 × ·015-·018 mm.; sperm cell ·003-·0035 × ·006-·007 mm.

Wittr. Mon. Œdog. p. 16. Archer, Quart. Journ. Micr. Sci., 1875, xv., p. 102.

Ireland (rare).

Plate LIX. fig. 4. *Œdogonium excisum*, with oogonia; *a*, section of oospore × 400.

Œdogonium Archerianum, *Cooke.*

Monœcious; oospore elliptic, its wall marked by somewhat coarse longitudinal striæ, not filling the cavity of the much larger and elliptic oogonium; aperture of the oogonium very high up, being quite close to the annular striæ of the caps.

Œdogonium Pringsheimianum, Archer, in Quart. Journ. Micr. Sci., 1868, pp. 295.

Ireland.

There being already a species bearing the name of *Œdogonium Pringsheimii,* which had priority, it became necessary to alter Mr. Archer's specific name. We have *not* seen the species, and hence are unable to furnish a figure. Unfortunately no measurements are given with the above very brief description, which is a doubtful economy of space. It is the only monœcious species with striate elliptical oospores.

SECTION II. Diœcious species.

A. *Dwarf males unicellular.*

a. Oogonia furnished with verticellate median processes.

Œdogonium platygynum. *Wittr. Œdog. Nov. p.* 1.

Gynandrosporous. Oogonia single (very rarely binate), depressedly obverse egg-shaped, median processes 7-12, rounded; oogonia cut round (circumscissile) below the middle, opening by a pore seated in the fissure, vertical view ·orbicular, margin sinuate, with 7-12 (usually 8) depressions; oospores rather depressedly globose, nearly filling the oogonium, androsporangia 1-3 celled; terminal cell obtuse. Dwarf males obverse egg-shaped, small, seated on the oogonia.

SIZE. Cells ·006-·01 mm., from 2-5 times as long; oogonia ·021-·03 × ·016-·024 mm.; oospore ·017-·024 × ·015-·02 mm.; androsp. cell ·006-·008 × ·007-·008 mm.; dwarf males ·0045-·005 × ·0085-·0095 mm.

Wittr. Mon. Œdog. p. 17, t. 1, f. 5-9. Kirch. Alg. Schles. p. 53.

Ireland.

Plate LIX. fig. 5. *Œdogonium platygynum,* with oogonium; *a,* transverse section of oospore × 400.

b. Oogonia destitute of median processes.

a Oospores globose or subglobose.

Œdogonium Rothii. (*Le Clerc.*) *Prings. Beitr.* 69, *t.* 5, *f.* 4.

Gynandrosporous. Oogonia single, or 2-6 continuous, globose, or rather depressedly globose, opening with a pore at the middle. Oospores rather depressedly globose, almost filling the oogonia. Androsporangia 2-4 celled, subhypogynous; dwarf males obversely egg-shaped, seated on the oogonia.

SIZE. Cells ·006-·008 mm., 3-8 times as long; oogonia ·02-·021 × ·016-·019 mm.

Wittr. Mon. Œdog. p. 18. Kirch. Alg. Schl. p. 53. Rabh. Alg. Eur. iii. 348.
Vesiculifera Rothii, Hassall, t. 53, f. 7 ?
Prolifera Rothii, Le Clerc Prolif. 476, t. 23, f. 8 ?

Scotland, Ireland, England.

Mr. Archer mentions this plant as having been found by him with a chain of as many as eleven oogonia in succession.—*Quart. Micro. Journ.*, 1866, p. 69.

Plate LIX. fig 6. *Œdogonium Rothii* with oogonia, androsporangia, and dwarf males × 400.

Œdogonium Areschougii. *Wittr. Disp. Œdog. p.* 122.

Gynandrosporous. Oogonia 2-6, continuous or single, rather depressedly globose, broadly cut round (circumscissile) in the middle, opening by a pore in the fissure. Oospore exactly globose, not by any means filling the oogonium. Androsporangia 1-6 celled, hypogynous or subepigynous, or rarely scattered, terminal cell (which sometimes is the androsporangium), obtuse, dwarf males obversely egg-shaped, seated on the oogonia.
SIZE. Cells ·008-·012 mm., 4-6 times as long; Oogonia ·038-·039 × ·036-·04 mm.; oospore ·022-·024 × ·022-·024 mm.; androsp. cells ·01-·011 × ·01-·012 mm.; dwarf males ·006-·007 × ·014-·015 mm.
Archer in Quart. Journ. Micr. Sci. 1872, xii., p. 422. Wittr. Mon. Œdog. p. 19.

Ireland.

Plate LIX. fig 7. *Œdogonium Areschougii* with oogonia, androsporangia, and dwarf males × 400—after Wittrock.

Œdogonium pluviale. *Nordst. Rab. Alg. Eur. No.* 2257.

Idio-androsporous. Oogonia simple, rarely 2-3 continuous, obversely egg-shaped, globose, or nearly globose, opening by a terminal operculum, fissure narrow; oospores nearly globose, almost filling the oogonium, terminal cell obtuse, filaments bearing the androsporangia a little slenderer than the female filaments; androsporangia 6-10 celled; dwarf males broadly obverse egg-shaped, seated on the oogonia.
SIZE. Cells ·018-·028 mm., equal to three times as long; oogonia ·034-·039 × ·034-·045 mm.; oospore ·032-·037 × ·031-·04 mm.; androsp. cell ·017-·019 × ·006-·011 mm.; dwarf males ·01 × ·015 mm.
Wittr. Mon. Œdog. p. 19.
Œdogonium diplandrum, Jur. Beitr. Œdog. p. 27, t. 1-3.
Vesiculifera dissiliens, Hass. F. W. Alg. 202, t. 50, f. 7.

Plate LIX. fig. 8. *Œdogonium pluviale* with oogonia and dwarf male × 400.

Œdogonium undulatum. (*Breb.*) *Br. in De Bary Œdog. p.* 94.

Oogonia single or twin, ellipsoid-globose, or nearly globose, opening by a pore below the middle; oospores ellipsoid-globose, or nearly globose, nearly filling the oogonia; vegetative cells four times undulatingly constricted; terminal cell (which sometimes is the oogonium) obtuse; dwarf males obconical, seated on the supporting cells.

SIZE. Cells ·015-·017 mm., 3-5 times as long; oogonia ·051-·056 × ·057-·075 mm.; oospores ·046-·05 × ·048-·06 mm.; dwarf males, ·009-·01 × ·0.

Wittr. Mon. Œdog. p. 20. Kirch. Alg. Schles. p. 54. Rabh. Alg. Eur. iii. 351.

Conferva undulata, Brebisson.

Cymatonema confervaceum, Kutz. Tab. iii., t. 47, f. 1.

Scotland.

Plate LIX. fig. 9. *Œdogonium undulatum* with oogonia and dwarf male × 400.

Œdogonium Reinschii. *Roy MSS.*

Mr. Roy has announced that the *Cymatonema* figured by Reinsch (*Contrib. t.* 6, *f.* 7) has been found in Scotland, and is a genuine *Œdogonium*, but no further details have transpired, and we know nothing of the fructification. The sterile cells are figured on Plate LVII. fig. 23.

B. *Dwarf males bicellular, spermogonia internal.*

Œdogonium depressum. *Prings. Beitr.* 69, *t.* 5, *f.* 5

Gynandrosporous. Oogonia single, depressedly globose, opening by a pore at the middle. Oospores depressedly globose, not filling the oogonia; androsporangia 2-celled; dwarf males oblong, obversely egg-shaped, one-third part shorter than the oogonia on which they are seated.

SIZE. Cells ·008-·009 mm., 3-6 times as long; oogonia ·028 × ·026 mm.; oospores ·023 × ·017 mm.

Wittr. Mon. Œdog. p. 21. Kirch. Alg. Schles. p. 54. Rabh. Alg. Eur. iii. 349.

Vesiculifera æquale, Hassall, t. 53, f. 3?

Scotland.

Plate LX. fig. 1. *Œdogonium depressum* with oosporangia, oospores, dwarf males, and bicellular androsporangia × 400.

C. *Dwarf males bimulticellular, spermogonia external.*

a. Oospores with smooth membrane.

α Oospores globose or subglobose.

Œdogonium flavescens. (*Hass.*) *Wittr. Disp. Œdog. p.* 127

Idio-androsporous. Oogonia single, egg-shaped-globose (sometimes rather hexagonally globose), opening by a pore a little above the middle; oospores globose, not filling the oogonia; androsporangia 1-9 celled; dwarf males a little curved, seated on the supporting cell; spermogonia 1 (or 2 ?) celled.

SIZE. Cells ·018-·021 mm. by $4\frac{1}{2}$ to 6 times as long; oogonia ·049-·052 × ·051-·060 mm.; oospore ·045-·049 × ·045-·049 mm.; androsp. cell ·017-·02 × ·008-·018 mm.; sperm. cells ·009-·01 × ·015-·02 mm.

Wittr. Mon. Œdog. p. 21, t. 1, f. 12-14.

Vesiculifera flavescens, Hass. F. W. Alg. 206, t. 53, f. 9.

Plate LX. fig. 2. *Œdogonium flavescens* with single and twin oogonia; *a*, androsporangia × 400.

Œdogonium Braunii. *Kutz. Sp. Alg. p.* 366.

Gynandrosporous. Oogonia single, ellipsoid, globose, opening with a pore at the middle; oospores globose, not filling the oogonia; androsporangia 1-2 celled; dwarf males a little curved, seated about the oogonium, often on the supporting cells; spermogonia 1-celled.

SIZE. Cells ·013-·015 mm., 2-4 times as long; oogonia, ·03-·033 × ·033-·036 mm.; oospore ·027-·029 × ·027-·029 mm.; androsp. cell ·014-·015 × ·011-·012 mm.; sperm. cell ·005 × ·009 mm.

Prings. Beitr. p. 70, t. 5, f. 6. Wittr. Mon. Œdog. p. 22. Kirch. Alg. Schles. p. 55. Archer in Quart. Journ. Micr. Sci. 1866, p. 69. Rabh. Alg. Eur. iii. 349.

Britain, Ireland.

Plate LX fig. 3. *Œdogonium Braunii* with oogonia, oospores, and dwarf males × 400.

Œdogonium macrandum. *Wittr. Disp. Œdog.* 130, *t.* 1, *f.* 3-5.

Oogonia single or twin (rarely three), obversely egg-shaped or globosely egg-shaped, opening by an operculum, with a very narrow fissure; oospores globose or egg-shaped globose, not filling the oogonia; terminal cell very shortly apiculate; dwarf males very much curved, seated on the oogonia (stem sometimes 2-3 celled); spermogonia many (to 7) celled.

SIZE. Cells ·015-·016 mm., 3-5 times as long; oogonia ·036-·04 × ·043-·054 mm.; oospore ·031-·034 × ·033-·039 mm.; sperm. cell ·009 mm.

Wittr. Mon. Œdog. p. 24. Archer Quart. Journ. Micr. Sci. 1875, xv., p. 413.

Ireland, Britain.

Plate LX. fig. 4. *Œdogonium macrandum* with oogonia and dwarf males × 400. Fig. 4. *a*, dwarf males seated upon the oogonium—after Wittrock.

Œdogonium crassiusculum. *Wittr. Disp. Œdog. p.* 132.

Gynandrosporous. Oogonia single, or twin, globose egg-shaped or nearly globose, opening by a pore above the middle; oospores ellipsoid-globose or globose; membrane very thick, almost filling the oogonia; androsporangia 2-5 celled; dwarf males nearly straight, seated on or about the supporting cells; spermogonia 1 (?) celled.

SIZE. Cells ·027-·03 mm., $3\frac{1}{2}$ to 5 times as long; oogonia ·054-·06 × ·06-·075 mm.; oospore ·051-·057 × ·052-·063 mm.; androsp. cells ·026-·028 × ·01-·018 mm.; sperm. cell ·007-·009 mm.

Wittr. Mon. Œdog. p. 24.

Epping Forest (1882).

We have only found this species once in pools on the Loughton side of Epping Forest, but the very thick coat of the oospore is remarkably distinct, combined with other characters, so as to render its determination certain.

Plate LX. fig. 5. *Œdogonium crassiusculum* with oogonium and dwarf males; *a*, androsporangia; o, mature oospore × 400.

b. Oospores ellipsoid or egg-shaped.

Œdogonium Borisianum. (*Le Clerc.*) *Wittr. Disp. Œdog. p.* 132.

Gynandrosporous (or idio-androsporous ?). Oogonia single or twin, obversely egg-shaped, opening by a pore above the middle; oospores obversely egg-shaped, almost filling the oogonia; supporting cells swollen; androsporangia 2 ? celled, terminal cell (which sometimes is the oogonium) obtuse, dwarf males a little curved, seated on the supporting cells; spermogonia unicellular.

SIZE. Cells ·015-·021 mm., 3-5 times as long; supporting cells ·03-·033 mm., twice as long; oogonia ·045-·05 × ·06-·075 mm.; oospore ·04-·044 × ·051-·054 mm.; androsp. cell ·017-·018 × ·015-·02 mm.; sperm. cell ·01 × ·021 mm.

Wittr. Mon. Œdog., p. 25. Kirch. Alg. Schles. p. 55.

Prolifera Borisiana, Le Clerc Prolif. 175, t. 23, f. 6.

Œdogonium apophysatum, Braun, in Kutz. Sp. Alg. p. 366. Kutz. Tab. Phy. iii., t. 35, f. 5. Rabh. Alg. Eur. iii., 251.

Œdogonium setigerum, Vaup. Iagt. Œdog. 17, t. 1. Archer in Quart. Journ. Micr. Sci. 1866, p. 69.

Britain, Ireland.

See Mr. Archer's detailed account of this species in the place above quoted.

Plate LX. fig. 6 *Œdogonium Borisianum*, with oogonium and thickened supporting cell bearing the dwarf males; *a*, androspore × 400.

Œdogonium concatenatum. (*Hass.*) *Wittr. Mon. Œdog. p.* 25.

Gynandrosporous. Oogonia 2-6 continuous, or single, egg-shaped, or quadrangularly ellipsoid, opening by a pore above the middle; oospores filling the oogonia, sporoderm delicately porose; supporting cell swollen; androsporangia 2-4 celled; terminal cell obtuse, dwarf males curved, seated on the supporting cells; spermogonia 2-4 celled.

Size.—Cells ·025-·04 mm., 3-10 times as long; supporting cells ·058-·062 mm., 2½ times as long; oogonia ·07-·083 × ·09-·105 mm.; oospores ·065-·076· × 087-·095 mm.; androsp. cell ·027-·028 × ·03-·036 mm.; sperm cell ·013-·015 × ·022-·025 mm.

Kirch. Alg. Schles. p. 55.

Vesiculifera concatenata, Hassall F. W. Algæ t. 51, f. 6.

Œdogonium apophysatum, Pringsh. Beitr. p. 71, t. 5, f. 9. Rabh. Alg. Eur. iii., 351, in part.

Britain.

Plate LXI. fig. 1. *Œdogonium concatenatum,* with oogonium and thickened supporting cell bearing the dwarf males; *a,* androsporangia × 400.

Œdogonium acrosporum. *De Bary. Œdog. p.* 60, *t.* 3, *f.* 1-12,

Idioandrosporous. Oogonia solitary, terminal, ellipsoid, opening by a small apical deciduous (or evanescent) operculum; oospore manifestly filling the oogonia, membrane longitudinally costate; supporting cells often swollen, terminal cell obtuse; dwarf males curved, seated on the supporting cells, stem often bicellular, upper cells of the stem very long; spermogonia 1-2 celled.

Size.—Cells ·01-·014 mm., 2-7 times as long; supporting cells ·015-·018 mm., 2-3 times as long; oogonia ·03-·035 × ·045-·051 mm.; sperm. cell ·006-·008 × ·014-·015 mm.

Archer in Quart. Journ. Micr. Sci. 1867, p. 80, 1868, p. 295. Wittr. Mon. Œdog. p. 16. Rabh. Alg. Eur. iii, 351.

Britain, Ireland.

The terminal oogonia are characteristic of this species, which can scarcely be confounded with any other.

Plate LXI. fig. 2. *Œdogonium acrosporum,* with terminal oogonia, after De Bary × 400.

Œdogonium ciliatum. (*Hass.*) *Prings. Beitr.* 70, *t.* 5, *f.* 8.

Gynandrosporous. Oogonia 2-7, continuous or single, egg-shaped, opening by an operculum, with a broad fissure; oospores egg-shaped, nearly filling the oogonia; androsporangia 2-8 celled, terminal cell setiform, dwarf males curved, seated on the oogonium; spermogonia unicellular.

Size. Cells ·015-·023 mm., $2\frac{1}{2}$ to 4 times as long; oogonia ·043-·05 × ·055-·072 mm.; oospore ·04-·046 × ·047-·057 mm.; androsp. cell ·018-·02 × ·016-·02 mm.; sperm. cell ·008-·01 × ·01-·011 mm.

Wittr. Mon. Œdog. p. 27. Kirch. Alg. Schles. p. 56. Rabh. Alg. Eur. iii., 347.

Vesiculifera ciliata, Hass. F. W. Algæ 202, t. 52, f. 2.

Œdogonium piliferum, Auers. Rab. Alg. Sachs. No. 474.

Britain, Ireland.

Plate LXI. fig. 3. *Œdogonium ciliatum*, with oogonia and dwarf males; *a*, androsporangia; *b*, small plant (after Pringsheim); *c*, androspore × 400.

b. Membrane of oospore echinulate. Oospores globose.

Œdogonium Cleveanum. *Wittr. Disp. Œdog. p.* 129.

Gynandrosporous. Oogonia single, subglobose, opening by a pore below the middle; oospores almost filling the oogonium, globose, spinulose, spines conical spirally disposed; androsporangia 4-6 celled, dwarf males a little curved, seated on the supporting cell; spermogonia unicellular.

Size. Cells ·018-·026 mm., 3-7 times as long; oogonia ·052-·06 × ·059-·063 mm.; oospores ·049-·057 × ·051-·059 mm.; spines ·004 mm. long; androsp. cell ·018-·022· × 009-·018 mm.; sperm. cell ·008-·0085 × ·014-·016 mm.

Wittr. Mon. Œdog. p. 28. Kirch Alg. Schles. p. 56.

Œdogonium echinospermum, Pringsh. Beitr. 70, t. 5, f. 7. Rabh. Alg. Eur. iii., 349, in part.

Ireland.

Plate LXII. fig. 1. *Œdogonium Cleveanum* with oogonia, and echinulate oospores; *a*, androsporangia × 400.

Œdogonium echinospermum. *Br. in Kutz. Sp. Alg.* 366.

Gynandrosporous, or idiandrosporous. Oogonia single, ellipsoid-globose, or nearly globose, opening by a pore at the middle; oospore almost filling the oogonia, globose, echinulate; spines awl-shaped; androsporangia 2-5 celled, dwarf males a little curved, seated on the supporting cells; spermogonia unicellular.

Size. Cells ·018-·03 mm., $2\frac{1}{2}$-$4\frac{1}{2}$ times as long; oogonia ·04-·05 × ·042-·057 mm.; oospore ·038-·047 × ·038-·049 mm.; spines ·003 mm. long; androsp. cell ·021-·025 × ·009-·015 mm.; sperm. cell ·01-·012 × ·012-·015 mm.

Archer in Quart. Journ. Micr. Sci. 1866, p. 69, 1867, pp. 80. Kutz. Tab. Phyc. iii., t. 36, f. 2. DBary Œdog. t. 3, f. 13-22. Wittr. Mon. Œdog. p. 29. Kirch. Alg. Schles. p. 56. Rabh. Alg. Eur. iii., 349.

Ireland, Scotland.

Of these two species with echinulate oospores, the spines of the former are broader at the base and conical, whilst in this they are slender, and but slightly thickened downwards.

Plate LXII. fig. 2. *Œdogonium echinospermum*, with oogonia and echinulate oospores × 400.

SUB-SECTION II. Diœcious, with elongated male plants. Oogonia, not, or scarcely, swollen.

Œdogonium capillare. (*Lin.*) *Kutz. Phyc. Gen.* 225, *t.* 12, *f.* 1-10.

Oogonia single, not swollen, cylindrical, opening by a pore above the middle; oospores globose or cylindrical-globose (somewhat quadrangular in longitudinal section) not filling the oogonia; male plants the same or almost the thickness of the female plants; spermogonia 1-4 celled, alternate with the vegetative cells: spermatozoids binate.

SIZE. Cells ·035-·055 mm., equal or twice as long; oogonia $1\frac{1}{2}$ times as long; oospore ·03-·052 × ·039-·063 mm.; sperm. cell ·03-·048 × ·005-·006 mm.

Kirch. Alg. Schles. p. 56. Rabh. Alg. Eur. No. 1180, 1417. Wittr. Mon. Œdog. p. 30.

Conferva capillaris, Linn. Spec. Pl. 1636.

Œdogonium regulare, Vaup. Beitr. Œdog. p. 213, t. 1, f. 1-10, not the *Vesiculifera capillaris* of Hassall.

Britain.

Plate LXII. fig. 3. *Œdogonium capillare*, with oogonia × 400.

b. Oospores manifestly swollen.

aa. Oospores globose, or nearly so.

Œdogonium calcareum. *Cleve in Wittr. Disp. Œdog. p.* 135.

Oogonia single (very rarely twin), depressedly globose, opening by a pore at the middle; oospores filling the oogonia, male plants the same, or almost the same, thickness as the female; spermogonia 2-5 celled; spermatozoids single (?).

SIZE. Cells ·011-·014 mm., 2-4 times as long; oogonia ·027-·03 × ·021-·023 mm.; oospores ·026-·028 × ·02-·021 mm.; sperm. cell ·01-·011 × ·009-·012 mm.

Wittr. Mon. Œdog. p. 32.

Vesiculifera compressa, Hass. F. W. Algæ, 204, t. 53, f. 4.

Œdogonium compressum, Rabh. Alg. Eur. iii., 348.

Britain.

Specimens from the warm tank in the Victoria House, Kew Gardens, had shorter cells than usual. It has apparently a tendency to become more or less coated with a deposit of lime.

Plate LXII. fig. 4. *Œdogonium calcareum*, with portions of male and female plants; *a*, female plant from Victoria tank, Kew Gardens × 400.

Œdogonium cardiacum (*Hass*). *Wittr. Disp. Œdog.* 135.

Oogonia single, between heart-shaped and globose, opening by a pore a little above the middle; oospores globose, not filling the oogonia; male plants a little slenderer than the female; spermogonia 2-10 celled; spermatozoids binate, terminal cells obtuse.

SIZE. Cells: fem. ·018-·03 mm. 2-7 times as long; cells: male ·015-·025 mm. 2-6 times as long; oogonia ·05-·07 × ·058- 086 mm.; oospore ·042-·06 × ·042-·06 mm.; sperm. cell ·015-·021 × ·01-·013 mm.

Wittr. Mon. Œdog. p. 33; Kirch. Alg. Schles. p. 57.
Vesiculifera cardiaca, Hass. F. W. Algæ 203, t. 51, f. 4.
Vesiculifera pulchella, Hass. F. W. Algæ 199, t. 50, f. 3.
Œdogonium pulchellum, Rabh. Alg. Eur. iii. 356.

Britain.

Plate LXII. fig. 5. *Œdogonium cardiacum*, oogonia with oospores × 400.

Œdogonium carbonicum. *Wittr. Mon. Œdog.* p. 74.

Oogonia single or twin, obversely egg-shaped—or ovate—globose, opening by a pore above the middle; oospores ellipsoid-globose or nearly globose, scarce filling the oogonia; male plants a little slenderer than the female; spermogonia 2-5 celled; spermatozoids binate; terminal cell obtuse.

SIZE. Cells: fem. ·016-·03 mm. 3-6 times as long; cells: male ·014-·016 mm. 3-6 times as long; oogonia ·043-·052 × ·05-·072 mm.; oospore ·042-·05 × ·046-·056 mm.; sperm. cell ·013-·014 × ·012-·014 mm.

Britain.

Plate LXIII. fig. 1. *Œdogonium carbonicum* with oospores. 1. *a*, portion of male plant with spermogonia × 400.

Œdogonium Pringsheimii. *Cramer. Hedw.* III. 17 *t*, 1 *c*, *f.* 1-4.

Oogonia single or 2-6 continuous, somewhat egg-shaped globose, opening by an operculum, with a very narrow and scarcely distinct fissure; oospores globose, not distinctly filling the oogonia; male plants a little slenderer than the female; spermogonia 2-10 celled, alternate with the vegetative cells in the upper part of the filament; terminal cell obtuse or rarely shortly apiculate.

SIZE. Cells: fem. ·012-·02 mm. 2-4 times as long; cells: male ·011-·016 mm. 2-4 times as long; oogonia ·03-·043 ×

·036-·045 mm.; oospore ·028-·035 × ·028-·034 mm.; sperm. cell ·01-·015 × ·006-·009 mm.

Kirch. Alg. Schles. p. 57; Rabh. Alg. iii. 348. Rabh. Alg. Eur. No. 790; Wittr. Mon. Œdog. p. 33, t. 1, fig. 16-17.

Œdogonium Nordstedtii, Wittr. Œdog. Nov. 6, t. 1, f. 7-8.

Britain.

Plate LXIII. fig. 2. Œdogonium Pringsheimii, with oogonia × 400.

Œdogonium punctato-striatum. *De Bary Œdog. t.* 2, *f.* 15-16.

Oogonia single, depressedly globose, manifestly splitting round (circumscissile) in the middle, opening by a pore in the fissure; oospore depressedly globose, nearly filling the oogonia; male plants a little slenderer than the female; spermogonia 3-7 celled; spermatozoids single; membrane of the vegetative cells and of the oogonia spirally punctate; basal cell depressedly globose; membrane vertically plicate.

Size. Cells: fem. ·018-·022 mm. 2-6 times as long; cells: male ·016-·019 mm. 2-6 times as long; oogonia ·048-·055 × ·038-·048 mm.; oospore ·044-·051 × ·035-·043 mm.; sperm. cell ·016-·018 × ·006-·01 mm.

Barker. P., in Quart. Jour. Micr. Sci. 1871, p. 94; Rabh. Alg. iii. 354. Rabh. Alg. Sachs. 214. Wittr. Mon. Œdog. p. 34. Rabh. Alg. Eur. No. 2276. Kirch. Alg. Schles. p. 57.

Ireland.

Distinguished by the cell wall being marked by spiral striæ of a dotted character, finely and closely set; these seen in an empty cell, through and through, the upper and lower striæ being nearly in focus simultaneously produce a somewhat decussate appearance.

Plate LXIII. fig. 3. Œdogonium punctato-striatum, with oogonium × 400.

bb. Oospores ellipsoid or egg-shaped.

Œdogonium Boscii (*Le Clerc*). *Wittr. Lisp. Œdog. Suec. p.* 136.

Oogonia single, rarely twin, oblong-ellipsoid, opening by a pore above the middle; oospores ellipsoid, by no means filling the oogonia, longitudinally costate; male plants the same or nearly the thickness of the female; spermogonia 3-6 celled; spermatozoids binate; terminal cell slender and somewhat hyaline.

Size. Cells ·014-·02 mm. 4-6 times as long; oogonia ·04-·045 × ·08-·1 mm.; oospore ·036-·04 × ·06-·065 mm.; sperm. cell ·013-·014 × ·006-·009 mm.

Wittr. Mon. Œdog. p. 34. Rabh. Alg. Eur. iii. 357. Rabh. Alg. Eur. No. 2198, 2369.

Vesiculifera Boscii, Hassall Algæ t. 52, f. 3, 4, 5.
Prolifera Boscii, Le Clerc Prolif. 474, t. 23, f. 5.
Vesiculifera elegans, Hass. Ann. Nat. Hist.

England.

Plate LXIII. fig. 4. *Œdogonium Boscii*, with oogonia × 400.

Œdogonium tumidulum. *Kutz. Deč. Alg. No.* 60.

Oogonia single, ellipsoid egg-shaped, opening by a pore above the middle, almost filling the oogonium; male plants a little slenderer than the female; spermogonia 6-45 celled; spermatozoids binate.

SIZE. Cells: fem. ·018-·025 mm. $3\frac{1}{2}$-5 times as long; cells: male ·015-·018 mm. 4 times as long; oogonia ·056-·058 × ·078-·09 mm.; oospore ·049-·054 × ·061-·068 mm.; sperm. cell ·015-·017 × ·009-·012 mm.

Wittr. Mon. Œdog. p. 35. Kirch. Alg. Schles. p. 58 (not of Pringsheim).

Ireland.

Plate LXIII. fig. 5. *Œdogonium tumidulum* with oogoninm. 5 *a*, portion of male plant with spermogonia × 400.

Œdogonium Landsboroughii (*Hass*). *Wittr. Mon. Œdog. p.* 35.

Oogonia single, rarely twin, obversely egg-shaped, opening by a pore above the middle; oospores obversely egg-shaped, filling the oogonia (or rarely ellipsoid and not filling the oogonia); male plants a little slenderer than the female; spermogonia 5-25 celled; spermatozoids binate, with a vertical division; terminal cell obtuse.

SIZE. Cells: fem. ·033-·036 mm. 4-6 times as long: cells: male ·031-·033 mm. 4-6 times as long; oogonia ·063-·075 × ·1-·12 mm.; oospore ·057-·07 × ·075-·1 mm.; sperm. cell ·027-·03 × ·009-·012 mm.

Kirch. Alg. Schles. p. 58.
Œdogonium rivulare, Rabh. Alg. iii. p. 350, in part.
Vesiculifera Landsboroughii, Hassall, F. W. Algæ t. 51, f. 2.
Œdogonium gemelliparum, Hantsch, Rab. Alg. Eur. 1118.
Œdogonium gemelliparum v. *major*, Wittr. Disp. Œdog. p. 137.

Britain.

Plate LXIV. fig. 1. *Œdogonium Landsboroughii*, with oogonia and oospores × 400.

var β. **gemelliparum** (*Prings*). *Wittr. Mon. Œdog. p.* 36.

Smaller than the typical form. Oogonia egg-shaped; oospores filling the oogonia; terminal cell very long, somewhat hyaline.

Size. Cells: fem. ·02-·027 mm. 3-5 or 8 times as long; oogonia ·055-·057 × ·075-·08 mm.; oospore ·049-·051 × ·065-·069 mm.

Kirch. Alg. Schles. p. 58. Archer in Quart. Journ. Micr. Sci. 1866, p. 69.

Œdogonium gemelliparum, Pringsh. Beitr. p. 71.

Ireland.

Plate LXIV. fig. 2. *Œdogonium Landsboroughii*, variety *gemelliparum*, with oogonium × 400.

Œdogonium rivulare (*Le Clerc*). *Braun, Chytr. p.* 23, *t.* 1, *f.* 1-10.

Oogonia single, or 2-7 continuous, obversely egg-shaped, opening by a pore above the middle; oospores obversely egg-shaped, rarely ellipsoid or nearly globose, not by a long way filling the oogonia; male plants a little slenderer than the female; spermogonia 3-9 celled; spermatozoids binate.

Size. Cells: fem. ·045-·045 mm. 3-8 times as long; cells: male ·03-·036 mm. 4 times as long; oogonia ·07-·085 × ·13-·16 mm.; oospore ·055-·07 × ·065-·1 mm.; sperm. cell ·021-·028 × ·014-·016 mm.

Wittr. Mon. Œdog. p. 36. Kirch. Alg. Schles. p. 58. Rabh. Alg. Eur. iii. 350 in part.

Prolifera rivularis, Le Clerc Prolif. 472, t. 23, f. 1.

Scotland.

Plate LXIV fig. 3. *Œdogonium rivulare*, with oogonium and oospore × 400.

Species of which the organs of fructification are imperfectly known.

a. Oospores globose or sub-globose.

Œdogonium delicatulum. *Kutz. Tab.* III., *t.* 33, *f.* 3.

Pallid, basal cell scarcely lobed at the base, affixed, cells cylindrical; oogonia subglobose, inflated, a little extended at either pole; oospore perfectly globose.

Size. Cells ·005-·006 mm., 3 times as long; oogonia ·02 × ·017 mm.; oospores ·012-·014 mm.

Rabh. Alg. Eur. 355. Rabh. Alg. Ex. No. 1156.

Deeside (Scotland).

Plate LXVI. fig. 7. *Œdogonium delicatulum*, with oogonia × 400.

Œdogonium tenellum. *Kutz. Tab.* III., *t.* 33, *f.* 9.

Basal cell two to three lobed, at first fixed, terminal joint obtuse, cells cylindrical or rather clavate; oogonia very much inflated; oospore globose, bright orange.

Size. Cells ·009-·011 mm., 4-8 times as long; oogonia ·025 mm. diam; oospore ·016-·018 mm.
Rabh. Alg. Eur. iii., 355.

Deeside (Scotland).

Plate LXVI. fig. 6. *Œdogonium tenellum*, with oogonia × 400.

Œdogonium hexagonum. *Kutz. Tab.* iii., *t.* 35, *f.* 3.

Oogonia almost globose; oospores globose, rufous-brown, not filling the oogonia; basal cell bifurcate; terminal cell often setigerous.
Size. Cells ·011-·013 mm. 2-4 times as long; oogonia ·025 × ·025 mm.; oospore ·016 mm.
Rabh. Alg. Eur. iii. 354.
Vesiculifera hexagona Hassall Algæ t. 53, f. 11-12.

Deeside (Scotland).

Plate LXVI. fig. 8. *Œdogonium hexagonum*, with oogonia × 400.

Œdogonium Londinense. *Wittr. Mon. Œdog. p.* 39.

Monœcious? oogonia twin or single, globose, cut round (circumscissile) in the middle, opening by a pore seated in the fissure; oospores globose, almost filling the oogonia; spermogonia (or androsporangia?) 1-2 celled, hypogynous.
Size. Cells ·01-·015 mm. $1\frac{1}{2}$ to 5 times as long; oogonia ·033-·035 × ·033-·043 mm.; oospore ·027-·032 × ·027-·032 mm.; sperm. cells ·026-·027 × ·027-·029 mm.

England.

Plate LXV. fig. 4. *Œdogonium Londinense* with oogonia × 400.

Œdogonium fasciatum. *Kutz. Tab.* iii., *t.* 34, *f.* 6.

Oogonia somewhat globose; oospores globose, rufous-brown, almost filling the oogonia; basal cell usually bilobate, terminal cell obtuse.
Size. Cells ·028-·03 mm., twice as long; oogonia ·04 mm.; oospore ·03-·032 mm.
DeBary Œdog. t. 3, f. 23-28. Rabh. Alg. Eur. iii., 354.
Vesiculifera fasciata Hassall Algæ t. 53, f. 6.

Deeside (Scotland).

Plate LXVI. fig. 2. *Œdogonium fasciatum*, with oogonia × ·400.

Œdogonium capillaceum. *Kutz. Phy. Gen.* 255.

Dark green, basal cell attenuated downwards, bifid, terminal point obtuse, cells sub-cylindrical; oogonia broadly elliptical, 2-4 often contiguous, opening by a lateral pore; oospore nearly globose, rufous-brown when mature, loosely involved in the oogonium.

SIZE. Cells ·02-·025 mm. $1\frac{1}{2}$-3 times as long; oogonia ·05 × ·04 mm.; oospore ·03-·032 mm.

Kutz. Tab. iii., t. 39, f. 6. Rabh. Alg. Eur. iii., 353.

Deeside (Scotland).

Plate LXVI. fig. 3. *Œdogonium capillaceum*, with oogonia × 400.

Œdogonium Hutchinsiæ. *Wittr. Mon. Œdog. p.* 42.

Oogonia single, rather depressedly to somewhat egg-shaped globose, opening by a pore above the middle; oospores filling the oogonium, epispore punctate with little warts; supporting cells swollen.

SIZE. Cells ·03-·035 mm., 4-6 times as long; oogonia ·062-·075 × ·065-·095 mm.; oospores ·06-·073 × ·055-·072 mm.; supporting cells ·04-·05 mm. 2-4 times as long.

Ireland.

The figure is taken from original specimens from Miss Hutchins in the Royal Herbarium at Kew.

Plate LXV. fig. 1. *Œdogonium Hutchinsiæ*, with oogonia × 400.

Œdogonium princeps. (*Hass*). *Wittr. Mon. Œdog. p.* 42.

Oogonia single, somewhat egg-shaped globose, opening with a pore above the middle; oospores globose, not distinctly filling the oogonium.

SIZE. Cells ·037-·045 mm. $1\frac{1}{4}$-$2\frac{1}{4}$ times as long; oogonia ·061-·075 × ·068-·08 mm.; oospore ·058-·066 × ·06-·065 mm.

Vesiculifera princeps Hass. F. W. Alg. 195.

Vesiculifera capillaris Hass. F. W. Alg. 195, t. 50, f. 1-2.

England.

Plate LXV. fig. 2. *Œdogonium princeps*, with oogonia and (*a*) spermogonia (?) × 400.

b. Oospores subelliptic or oval.

Œdogonium longatum. *Kutz. Sp. Alg. p.* 364.

Oogonia single (often solitary, terminal), rarely 2-3 continuous, ellipsoid, opening by an operculum, with a narrow fissure; oospores globosely-ellipsoid, scarcely filling the oogonium; terminal cell obtuse.

SIZE. Cells ·005-·006 mm. 2-3 times as long; oogonia ·016-·017 × ·021-·024 mm.; oospores ·015-·016 × ·0175-·0185 mm.

Kutz. Tab. Phy. iii., t. 33, f. 6. Wittr. Mon. Œdog. p. 38.

Britain.

Plate LXIV. fig. 4. *Œdogonium longatum,* parasitic upon another species, with oogonia × 400.

Œdogonium vesicatum. (*Lyngb.*) *Wittr. Mon. Œdog. p.* 39.

Oogonia single, ellipsoid, globose, opening by an operculum, with a narrow fissure; oospores ellipsoid-globose, almost filling the oogonium.

SIZE. Cells ·017-·21 mm. $1\frac{1}{4}$-3 times as long; oogonia ·043-·045 × ·051-·06 mm.; oospore ·037-·038 × ·041-·042 mm.

Kirch. Alg. Schles. p. 59.

Conferva vesicata Lyngb. Hydro. 144, t. 47, f. D 1. Eng. Bot. t. 2476.

Scotland.

Plate LXV. fig. 5. *Œdogonium vesicatum,* with oogonium × 400.

Œdogonium grande. *Kutz. Tab. Phy.* III, *t.* 37, *f.* 1.

Oogonia oval-elliptic, nearly twice as long as broad; oospores oval-elliptic, entirely filling the oogonia; basal cell contracted towards the base, then dilated and discoid; terminal cell obtuse.

SIZE. Cells ·025-·035 mm. 3-4 or 5 times as long; oogonia ·1 × ·07 mm.; oospore ·09 × ·065 mm.

DeBary Œdog. t. 2, f. 1-14. Rabh. Alg. Eur. iii., 353.

Scotland.

Plate LXVI. fig. 4. *Œdogonium grande,* with oogonium × 400.

Œdogonium giganteum. *Kutz. Phyc. Germ. p.* 200.

Oogonia single, a little swollen, cylindrically egg-shaped, opening with a pore above the middle; oospores cylindrically ellipsoid, nearly filling the oogonia (sometimes flask-shaped, short necked, and then filling the oogonia), epispore delicately scrobiculate, supporting cells rather swollen.

SIZE. Cells ·03-·024 mm. 2-$4\frac{1}{2}$ times as long; supporting cells ·054-·06 mm. $1\frac{1}{2}$-$1\frac{3}{4}$ times as long; oogonia ·057-·069 × ·078-·106 mm.; oospore ·054-·065 × ·075-·103 mm.

Kutz. Tab. Phyc. iii, t. 37, f. 2. Wittr. Mon. Œdog. p. 42. Kirch. Alg. Schles. p. 59.

Vesiculifera lacustris Hass. F. W. Algæ 198, t. 52, f. 1.

Œdogonium lacustre Rabh. Alg. Eur. iii, 356.

Plate LXV. fig. 3. *Œdogonium giganteum,* with oogonia × 400.

Œdogonium crassum. (*Hass.*) *Wittr. Gotl. Sotv. Alg. p.* 20, *t.* 1. *f.* 4-6.

Oogonia single (rarely twin), obversely egg-shaped ellipsoid, a little swollen, opening by a pore above the middle; oospores ellipsoid, not filling the oogonia.

SIZE.—Cells ·033-·055 mm. 2-5 times as long; oogonia ·065-·07 × ·1-·125 mm.; oospore ·06-·066 × ·08-·11 mm.

Wittr. Mon. Œdog. p. 43. Kirch. Alg. Schles. p. 59.

Vesiculifera crassa Hass. Alg. t. 51, f. 1.

Plate LXVI. fig. 1. Œdogonium crassum, with oogonium × 400.

Œdogonium subsetaceum. *Kutz. Spec. p.* 368.

Basal cell dilated and discoid at the base, rather lobed, terminal joint obtuse; oospores broadly oval, golden red, closely involved in the oogonium.

SIZE. Cells ·04-·052 mm. equal or twice as long; oogonia ·065 × ·055 mm.; oospore ·06 × ·05 mm.

Kutz. Tab. iii, t. 41, f. 1. Rabh. Alg. Eur. iii, 352.

Deeside (Scotland).

Plate LXVI. fig. 5. Œdogonium subsetaceum, with oogonium × 400.

GENUS 65. **BULBOCHŒTE.** *Ag.* (1817.)

Filaments articulated, branched, joints thickened upwards, at or about the apex bearing setæ, which are straight, hyaline, colourless, more or less elongated, bulbous at the base, cell membrane usually punctate; oogonia opening by a lateral pore above the middle; mature oospore red; monœcious or diœcious.

Reproduction sexual as in *Œdogonium*. In the diœcious species nannandrous (dwarf males).

The following arrangement of the British species is based on that of Prof. Wittrock:—

BULBOCHŒTE.

Sect. 1. Oogonia globose or subglobose, patent; oospores with the same form, and filling the oogonia. Diœcious.

A. *Dwarf males unicellular.*
None.

B. *Dwarf males bicellular.*

a. Basal cell of the stem of the male plants shorter than the spermogonia.

B. intermedia, *DBary.*
B. polyandra, *Cleve.*
B. Brebissonii, *Kutz.*
B. setigera, *Ag.*

b. Basal cell of the stem of the male plants longer than the spermogonia.
B. gigantea, *Pring.*

Sect. 2. Oogonia ellipsoid or subellipsoid; oospores of the same form, filling the oogonia, epispore longitudinally costate, costæ more or less crenulate.

Sub-Sect. 1. Species monœcious.
B. mirabilis, *Wittr.*

Sub-Sect. 2. Species diœcious.

A. *Dissepiment of supporting cell obsolete.*
B. pygmœa, *Pring.*

B. *Dissepiment of supporting cell present.*
B. insignis, *Prings.*
B. rectangularis, *Wittr.*

Species of which the organs of fructification are imperfectly known.
B. gracilis, *Prings.*

SECTION 1. Oogonia globose, or subglobose; diœcious.

B. *Dwarf males bicellular.*

Bulbochœte intermedia. *DeBary Œdog.* 72, *t.* 4, *f.* 1-7.

Oogonia somewhat depressedly globose, seated beneath the androsporangia, dissepiment of the supporting cell in the middle; epispore delicately crenulate (rarely seen); androsporangia 1-2 celled, epigynous, rarely scattered, dwarf males seated on the oogonia, stem slightly curved.

SIZE. Cells ·017-·019 mm. $1\frac{1}{2}$-3 times as long; androspore cells ·013 × ·01 mm.; oogonia ·04-·048 × ·031-·04 mm.; dwarf males ·009-·01 × ·024-·026 mm.

Wittr. Mon. Œdog. p. 44, t. 1, f. 18. Kirch. Alg. Schles. p. 60. Rabb. Alg. Eur. iii, 358.

Britain, Ireland.

Plate LXVII. fig. 1. *Bulbochæte intermedia,* with oogonia, after DeBary × 400.

Bulbochœte polyandra. *Cleve. Wittr. Disp. p.* 140.

Idio-androsporous. Oogonia sub-depressedly globose, seated beneath terminal setæ or vegetative cells; dissepiment of supporting cell above, or rarely about the middle; epispore delicately crenulate or nearly even; androsporangia 4-10 celled; dwarf males seated on the oogonia, stem a little curved.

SIZE. Cells ·015-·02 mm., 3-5 times as long; oogonia ·035-·046 × ·032-·038 mm.; androspore cell ·013-·014 × ·012-·015 mm.; dwarf males ·008-·009 × ·023 mm.

Wittr. Mon. Œdog. p. 46, t. 1, f. 19, 20. Kirch. Alg. Schles, p. 61.

Britain, Ireland.

Plate LXVII. fig. 2. *Bulbochæte polyandra,* with oogonia; 2*a*, with androsporangia × 400.

Bulbochœte Brebissonii. *Kutz. Tab. Phyc.* IV, 19, *t.* 86.

Oogonia obcordate-globose, truncate below, erect, seated beneath terminal setæ or androsporangia, dissepiment of supporting cell low, epispore delicately crenulate ; androsporangia 2-3 celled, scattered or epigynous ; dwarf males seated on the oogonia, rarely around it, stem straight, or nearly so.

SIZE. Cells ·017-·02 mm. by 3-4½ times as long; androspore cells ·015 × ·015-·018 mm.; oogonia ·042-·05 × ·037-·045 mm.; dwarf males ·01-·012 × ·028-·033 mm.

Wittr. Mon. Œdog. p. 46. Rabh. Alg. Eur. Exs. 1055. Rabh. Alg. Eur. iii. 359.

Ireland.

Plate LXVII. fig. 3. *Bulbochæte Brebissonii*, with oogonia, and dwarf males × 400.

Bulbochœte setigera. *Ag. Syn. Alg. Scan. p.* 71.

Oogonia depressedly, somewhat quadrangularly globose, seated beneath terminal setæ, or beneath androsporangia; membrane of the oogonium after fertilisation thickened; dissepiment of supporting cell a little above the middle, or at the middle; epispore granulated; androsporangia scattered or epigynous, bicellular; dwarf males seated upon or about the oogonia, stem straight.

SIZE. Cells ·025-·028 mm., 2½-5 times as long; androspore cells ·018-·02 × ·014-·018 mm.; oogonia ·075-·08 × ·06-·065 mm.; dwarf males, ·012-·013 × ·034-·036 mm.

Wittr. Mon. Œdog. p. 47. Prings. Beitr. 72, t. 6, f. 3. Kirch. Alg. Schles. p. 61. Rabh. Alg. Eur. iii., p. 358. Hass. Alg. t. 54, f. 1-4. Eng. Bot. ii. t. 2472. Eng. Fl. v, p. 350.

Conferva vivipara Dillw. Conf. t. 59. Eng. Bot. i, 2086.

Bulbochæte Rothii Gray. Arr. 1, 321 (?).

Britain, Ireland.

Plate XLVIII. fig. 1. *Bulbochæte setigera*, with oogonia and dwarf males; *a, b, c*, development of young plants × 400.

Bulbochœte gigantea. *Prings. Beitr.* 71, *t.* 6, *f.* 1.

Idio-androsporous? Oogonia rather depressed obcordate-globose, seated beneath terminal setæ, rarely beneath vegetative cells; dissepiment of supporting cell at or a little above the middle; epispore verrucose; dwarf males a little longer than the oogonia, and seated upon it; stem twice as long as the spermogonium, arcuate.

SIZE. Cells ·024-·027 mm. by 2-3 times as long; oogonia ·062-·066 × ·051-·058 mm.; stem of dwarf males ·011-·012 × ·04-·045 mm.; sperm. cell ·013-·014 × ·02-·022 mm.

Wittr. Mon. Œdog. p. 48. Kirch. Alg. Schles. p. 61. Rabh. Alg. Eur. iii., p. 357. Quart. Journ. Micr. Sci., 1866, p. 276.

Britain, Ireland.

Plate LXVIII. fig. 4. *Bulbochæte gigantea,* with oogonium and dwarf male × 400.

SECTION 2. Oogonia ellipsoid or subellipsoid.

SUB-SECTION 1. Species monœcious.

Bulbochæte mirabilis. *Wittr. Disp. Œdog.* 137, *t.* 1, *f.* 8, 9.

Oogonia ellipsoid, or rather oblong-ellipsoid, patent, or rarely erect, seated beneath terminal setæ or vegetative cells; spermogonia 2-4 celled, erect (rarely patent), subepigynous, or scattered.

SIZE. Cells ·016-·02 mm. $1\frac{1}{4}$-$1\frac{3}{4}$ times as long; oogonia ·027-·035 × ·046-·056 mm.; sperm. cell ·01-·012 × ·007-·009 mm.

Wittr. Mon. Œdog. p. 50.

Britain, Ireland.

Plate LXVIII. fig. 2. *Bulbochæte mirabilis,* with oogonia and androsporangia × 400.

SUB-SECTION 2. Species diœcious.

Bulbochæte pygmæa. *Wittr. Disp. Œdog. p.* 141.

Oogonia ellipsoid, patent, seated beneath terminal setæ, or vegetative cells, in longitudinal section rather quadrangular; androsporangia scattered, dwarf males seated about the oogonia. (Filament at first short, and curved.)

SIZE. Cells ·012-·015 mm. × a third part shorter or equal; oogonia ·023-·025 × ·034-·04 mm.; stem of dwarf males ·011-·012 × ·015-·018 mm.; sperm cell ·007-·0075 × ·007-·0075 mm.

Wittr. Mon. Œdog. p. 52. Quart. Journ. Micr. Sci. 1870, p. 89.

Bulbochæte pygmæa, β. minor, Prings. Beitr. p. 74, t. 6, f. 10.

Ireland, Britain.

Plate LXVIII. fig. 5. Plant of *Bulbochæte pygmæa,* with oogonium and (*a*) section of oospore × 400.

Bulbochæte insignis. *Prings. Beitr.* 72, *t.* 6, *f.* 7.

Oogonia ellipsoid, patent or erect, seated beneath androsporangia or terminal setæ; epispore delicately transversely striate; androsporangia epigynous, or rarely scattered; dwarf males seated about or upon the oogonia.

Size. Cells ·02-·025 mm. $2\frac{1}{2}$-$4\frac{1}{2}$ times as long; oogonia ·046-·05 × ·07-·1 mm.; androspore cell ·016-·02 × ·02-·025 mm.; stem of dwarf males ·017-·019 × ·029-·031 mm.; sperm. cell ·01-·011 × ·0075-·008 mm.

Wittr. Mon. Œdog. p. 55. Kirch. Alg. Schles. p. 62. Rabh. Alg. Eur. iii. 360.

Bulbochæte Pringsheimiana Arch. Proc. Dubl. Micro. Club p. 38, t. 4.

Ireland.

Plate LXVII. fig. 4. *Bulbochæte insignis*, with oogonium and dwarf male × 400.

Bulbochæte rectangularis. *Wittr. Disp. Œdog. p.* 142.

Oogonia ellipsoid, patent, or rarely erect, seated beneath terminal setæ, or androsporangia, or rarely beneath vegetative cells; androsporangia scattered or epigynous; vegetative cells somewhat rectangular in longitudinal section (horizontal division of vegetative cells often occurs). Branches of the plant few and very long; dwarf males seated about or upon the oogonia.

Size. Cells ·019-·023 mm., $1\frac{1}{4}$-2 times as long; oogonia, ·03-·039 × ·048-·055 mm.; androspore cell ·015-·016 × ·016-·027 mm.; stem of dwarf males ·015-·018 × ·022-·027 mm.; sperm. cell ·008-·0095 × ·0055-·0065 mm.

Wittr. Mon. Œdog. p. 56, t. 1, f. 22-24.

Ireland.

Plate LXVIII. fig. 3. *Bulbochæte rectangularis*, with oogonia and dwarf male × 400.

Species of which the organs of fructification are imperfectly known.

Bulbochæte gracilis. *Prings. Beitr.* 74, *t.* 6, *f.* 9.

Monœcious (?). Oogonia oblong-ellipsoid, patent or rarely erect, with vegetative cells above; supporting cells without dissepiment (?).

Size. Cells ·013-·014 mm., $1\frac{1}{4}$ to $1\frac{1}{2}$ times as long; oogonia ·021-·024 × ·049-·054 mm.

Wittr. Mon. Œdog. p. 57. Rabh. Alg. Eur. iii., 359. Quart. Journ. Micr. Sci. 1870, p. 89.

Ireland.

Plate LXVI. fig. 9. *Bulbochæte gracilis*, with oogonium × 400.

Family VI. ULOTRICHEÆ.

Algæ growing either in fresh water (*Ulothrix*), or marine or sub-marine (*Hormiscia*), or terrestrial (*Hormidium*, *Schizogonium*), either of a bright green or yellowish green colour. Threads very shortly articulate, simple, very rarely dividing into single branches, free, now and then laterally connate in bands (*Schizogonium*).

Primitive cells always many times longer than their diameter, after repeated division equal, or shorter (rarely a little longer), all fertile. Cell-membrane either thin (*Ulothrix*, *Hormidium*) or thick, sometimes very thick, and distinctly lamellose (*Hormiscia*). Cell-contents at first effused, parietal, including a starch granule, after simple or repeated division transmuted into gonidia.

Gonidia of two kinds, *Macrogonidia* sphærical, ovoid, or ovate-oblong, rounded at one pole, and acute at the other, furnished with 2 or 4 vibratile cilia, often germinating in the mother-cell without sexual fertilization. *Microgonidia* much smaller, of similar form, furnished with two cilia at one extremity. Both kinds of zoogonidia produced within the cells of the threads, emitted either by a poriform opening in the mother-cell, or by the splitting or breaking up of the mother-cell.

For detailed information on this family consult Braun's "Rejuvenescence" (Ray Society), pp. 148, 161, 184, 208, 223; Dr. A. Dodel, "die Kraushaar-Alge," *Ulothrix zonata*, in Pringsheim's "Jahrbucher," t. x.; Cienkowsky "Zur Morphologie der Ulotricheen" (1876); Thuret, in "Ann. des Sciences Naturelles," xiv. (1850), p. 222; and Dr. Braxton Hicks, in "Quarterly Journal of Microscopical Science," 1861, p. 157.

Genus 66. **HORMISCIA.** *Ares.* (1866.)

Articulate thread fixed by the basal cell, which is attenuated downwards; simple, or now and then emitting branchlets. Cells abbreviated, enclosed by a thick cell-membrane, which is often manifestly lamellose. Cell-contents green, parietal, including an amylaceous granule.

Propagation by macrogonidia and microgonidia.—*Rabh. Alg. Eur.* III. 361.

The filaments are sometimes cylindrical, sometimes torulose like a rosary, in consequence of the barrel-like inflation of the separate cells; sometimes stretched out, sometimes frilled and interlacing each other, with a relatively thicker stratified membrane. Vegetative or asexual reproduction is effected by macrozoospores, which originate 1-4 in a cell, and after becoming covered with a transparent bladder make their exit through an opening formed in the lateral wall of the mother-cell. The macrozoospores are of a thick, short, pear-shape, furnished with four cilia, a coloured spot, and a contractile vacuole. After a time they come to rest, and fixing themselves by the mouth end, they lose their cilia and envelope themselves in a membrane. The fixed end developes into a root-like, colourless organ of attachment; the free end growing into a club-shaped plantlet, through the cell, dividing into two by a cross partition, and each of these again in two, and so further. Sexual reproduction arises through repeated bipartition in each cell, from 8-32 and more, smaller microzoospores being produced. They have only two cilia, and after a swarming for a time they conjugate laterally in pairs, forming a zygospore, which attaches itself by the end corresponding to the mouth of the microzoospore. It grows very slowly, and finally breaks up by the simultaneous division of its plasma into 2-14 swarm-spores, which constitute the beginning of a new sexual generation. If any of the microzoospores remain behind in the mother cells, they are able, without copulation, to germinate and grow into independent plants which may be seen singly or in groups projecting from the mother-cells.

Hormiscia moniliformis. (*Kutz.*) *Rabh. Alg. Eur.* III., 361.

Pale green, more or less crispate, often mixed with other Algæ; cells equal or a little shorter than their diameter; cell-membrane thick, colourless, somewhat lamellose, more or less constricted at the septa.

SIZE. Cells ·011-·014 mm. diam.

Ulothrix moniliformis, Kutz. Tab. Phy. ii., t. 88. Kirch. Alg. Schl. p. 76.

In swamps, amongst *Sphagnum*, &c.

Plate LXX. fig. 1. Portions of threads of *Hormiscia moniliformis* × 400 diam.

Hormiscia zonata. (*Web. & M.*) *Aresch. Obs. p.* 12.

More or less bright green, mucous, two or three feet long, often less, either floating or interwoven, sterile cells equal, or half their diameter; fructiferous cells usually a little longer than broad; cell-membrane thick, slightly constricted at the septa.

SIZE. Cells ·012-·04 mm.; macrozoospores ·012-·018 × ·01 ·012 mm.; microzoospores ·005-·01 × ·004-·007 mm.

Rabh. Alg. Eur. iii., 362.

Ulothrix zonata, Kutz. Tab. Phy. ii., t. 90, f. 2. Kirch. Alg. Schl. p. 76. Dodel in Prings. Jahrb. t. x., pl. I.-VIII.

Lyngbya zonata, Hass. Alg. 220, t. 59, f. 1-6.

Conferva zonata, Web. & Mohr. in Ag. Syst. p. 90; Harv. Man. 126. Eng. Fl. v., p. 351. Mack. Hib. 224. Dillw. Conf. Syn. p. 41. Johnst. Fl. Berw. ii., 254. Gray Arr. i., 311.

Conferva lubrica, Dillw. Conf. t. 47.

Conferva lucens, Eng. Bot. i., t. 1655; ii., t. 2475.

In ditches, ponds, swamps, &c.

Plate LXIX. fig. a. } Threads in ordinary condition.
,, *b.* }
,, *c.* Portion of a thread with one macrozoospore in each cell showing the red spot.
,, *d.* Macrozoospores free with four cilia.
,, *e.* Macrozoospores in the resting state.
,, *f.* Macrozoospores germinating.
,, *g.* Plantlet of six cells.
,, *h.* Threads with ripe microzoospores.
,, *h2.* With macro and microzoospores.
,, *i.* Microzoospores free with two cilia.
,, *k.* Microzoospores in conjugation.
,, *l.* Resting zygospores, the result of the conjugation of pairs of zoospores.
,, *m.* Portion of threads with growing plantlets arising from uncopulated microzoospores left behind in the mother-cells.
,, *n.* Three healthy zygospores, 8 months and 9 days old.
,, *o.* Zygospore contents differentiating.
,, *p.* ,, in a later stage.
,, *q.* ,, very large in two positions, show. altogether 10 zoospores.
,, *r.* ,, with zoospores elongated.

Hormiscia æqualis. (*Kutz.*) *Rabh. Alg. Eur.* III., 363.

Yellowish-green, cells equal, or a little longer than their diameter; cell-membrane, rather thick.

var. **catenæformis.** *Kutz.*

Rather thicker than in the typical form; cells a little longer than their diameter; cell membrane thick, striate, manifestly constricted at the septa.

SIZE. Cells ·012–·018 mm. diam.

Ulothrix æqualis, Kutz. Tab. Phy. ii., t. 89, f. 1. Kirch. Alg. Schl. 76.

Ulothrix catenæformis, Kutz. Tab. Phy. ii., t. 89, f. 2.

In ditches and streams (mostly rapid) attached to aquatic plants.

Plate LXX. fig. 2. Portions of threads of *Hormiscia catenæformis* × 400 diam.

Hormiscia speciosa. (*Carm.*) *Rabh. Alg. Eur.* III., 363.

Dark green, 1-2 inches long, threads often crispate, cells 2-4 times shorter than their diameter, fructiferous cells subglobose.

SIZE. Cells ·043-·048 mm. diam.

Ulothrix speciosa, Kutz. Tab. Phy. ii., t. 93.

Lyngbya speciosa, Carm. Alg. App. ined. Harv. Phyc. Britt. t. 186 B. Brit. Fl. ii., 371. Wyatt Alg. Danm. No. 196.

In brackish and fresh water.

Scarcely any good features whereby this can be distinguished from *H. bicolor*.

Plate LXX. fig. 3. Portions of threads of *Hormiscia speciosa* × 400 diam.

Hormiscia bicolor. (*Eng. Bot.* I., *t.* 2288.)

Bright green. Tufts very long, one foot or more; articulations two to three times shorter than their diameter, pectinate; cell membrane thick, distinctly lamellose.

SIZE. Cells ·05 mm. diam.

Ulothrix crispa, Kutz. Tab. Phyc. ii., t. 92, f. 4. Kutz. Spec. 348.

Conferva bicolor, Eng. Bot. i., t. 2288.

Tyndaridea bicolor, Eng. Bot. ii., t. 2508. Eng. Fl. v., 361.

Ulothrix bicolor, Ralfs, Alg. Exs. No. 13.

(?) *Sphæroplea crispa*, Berk. Glean. t. 3, f. 1. Harv. Man. 144.

Lyngbya crispa, Jenner Fl. Tonb. Wells, 188.

In fresh water.

Whether this be really the *Sphæroplea crispa* of "Berkeley's Gleanings" seems open to reasonable doubt.

Plate LXX. fig. 7. Portion of thread of *Hormiscia bicolor* with microzoospores in lower cells × 400 diam.

GEN. 67. ULOTHRIX. *Kutz.* (1845.)

Threads articulate, simple; articulations short, sometimes shorter than their diameter, rarely a little longer; cell membrane thin, often very thin, very rarely lamellose. Cell contents effused, green, parietal, inclosing an amylaceous granule.

The slight differences between this genus and *Hormiscia* seems scarcely sufficient to maintain them as distinct genera.

Ulothrix variabilis. *Kutz. Tab. Phyc.* II., *t.* 85, *f.* 3.

Pale green ; cells equal or a little longer than their diameter, rarely twice as long ; cell-contents at first always contracted in a quadrate manner.
SIZE. Cells ·005-·007 mm.
Rabh. Alg. Eur. iii.
Ulothrix subtilis, var. c. *variabilis,* Kirch. Alg. Sch. 77.

In ditches and slow streams.

The view entertained by Kirchner that this and *U. tenerrima* are only varieties of *Ulothrix subtilis* is probably correct.

Plate LXX. fig. 4. Portions of threads of *Ulothrix variabilis* × 400 diam.

Ulothrix tenerrima. *Kutz. Tab. Phy.* II., *t.* 87, *f.* 1.

Pale green, or yellowish-green, lubricous ; cells mostly equal in length and diameter, now and then a little shorter.
SIZE. Cells ·007-·01 mm.
Rabh. Alg. Eur. iii., 366.
Ulothrix subtilis, var. *e. tenerrima,* Kirch. Alg. Schl. p. 77.

In ditches, turbaries, &c.

Plate LXX. fig. 5. Portions of threads of *Ulothrix tenerrima* × 400 diam.

Ulothrix tenuis. *Kutz. Tab. Phyc.* II., *t.* 89, *f.* 1, *bis.*

Dark green, attached, from half to two or three inches long, mucous, cells equal or 2-4 times shorter than their diameter, cell membrane thin, homogeneous.
SIZE. Cells ·017-·026 mm.
Rabh. Alg. Eur. iii., 366. Kirch. Alg. Schl. p. 78.

In ditches and streamlets.

Plate LXX. fig. 6. Portions of threads of *Ulothrix tenuis* × 400 diam.

Ulothrix (Hormidium) radicans. *Kutz. Tab. Phyc.* II., *t.* 95, *f.* 3.

Yellowish green, rather rigid, densely interwoven in a soft velvety green stratum, cells either nearly equal or 2-3 times shorter than their diameter.
SIZE. Cells ·0075-·0095 mm.
Rabh. Alg. Eur. iii., 367. Kirch. Alg. Schl. p. 77.
Hormidium murale, Kutz. Phy. Germ. p. 193.
Lyngbya muralis, Ag. Syst. p. 74. Eng. Fl. v , 370. Hass. Alg. 221, t. 59, f. 7. Eng. Bot. ii., t. 2522. Jenn. Tunb.

Wells, 188. Harv. Man. 160. Johnst. Fl. Berw. ii., 259. Mack. Hib. 238.

Conferva muralis, Dillw. Conf. t. 7. Eng. Bot. i., t. 1554.

Humida muralis, Gray Arr. i., 282.

Oscillatoria muralis, Grev. Fl. Ed. 304. Fl. Dev. ii., 57. Hook. Fl. Scot. ii., 79.

On the naked ground, rocks, walls, &c.

Kutzing has in some of his works applied to the terrestrial species of *Ulothrix* the generic name of *Hormidium*, which is only of sectional value.

Plate LXXI. fig. 1. Portions of threads of *Ulothrix radicans* × 400.

Ulothrix (Hormidium) parietina. (*Vauch.*) *Kutz. Tab. Phyc.* II., *t.* 97, *f.* 1.

Bright yellowish green, flexuous and interwoven, cells half as long as broad, cell membrane thin, hyaline, homogeneous.

SIZE. Cells ·009-·016 mm.

Rabh. Alg. Eur. iii., 367. Kirch. Alg. Schl. p. 78.

Hormidium parietinum, Kutz. Phyc. Germ. p. 193.

On walls, trunks, &c.

Plate LXXI. fig. 2. Portions of threads of *Ulothrix parietina* × 400 diam.

GEN. 68. **SCHIZOGONIUM.** *Kutz.* (1843.)

Threads as in *Ulothrix*, or in many places laterally connate (duplicate or triplicate), or by cellular division in two directions forming narrow flat bands, which are more or less crispate.

In 1861 Dr. Braxton Hicks indicated his belief that *Schizogonium* was only a condition of *Ulothrix* in which the threads had become connate, of which *Prasiola* was only a frondose form. He says, "the whole of these changes are so palpable, can be observed so constantly, and are, at the same time, so simple in their relations to one another, that one can scarcely imagine how they can have been separated, not only into distinct species, but into different families of Algæ. Thus the linear stage is called *Lyngbya* (Ulothrix); the early stage of collateral segmentation, the *Schizogonium;* the adult stage, the *Prasiola;* while the gonidial growth has been classed under *Palmellaceæ.*" And again, "the only real difference between the first two is, that whereas *Lyngbya* (Ulothrix) is a tube containing distinct cells within, which, when old undergo collateral subdivision, to form a band of two, four, or eight rows of cells, *Schizogonium* is a band of two or eight rows of cells, which, when young was but a single row, contained in a tube, which is only two different ways of stating the same facts. The comparison of the last two is of the same kind. For as *Prasiola*, when old, is composed of many rows of cells, but which arose from a single row, there must have been a time in its life when it had two, four, or eight rows, and thus have been a *Schizogonium*, for there is no other structural difference between the two." The whole of the communication from whence the above is quoted is worthy of attentive perusal, at least in so far as the relations between *Ulothrix* and *Schizogonium* are concerned. It is entitled "On the Diamorphosis of *Lyngbya*, &c.," in the "Quart. Journ. of Microscopical Science" for 1861, pp. 157–166.

Schizogonium murale. *Kutz. Tab. Phyc.* II., *t.* 98, *f.* 1.

Dark green, forming a broadly expanded soft velvety stratum, threads sometimes free, here and there two or three united, cells 2-4 times shorter than their diameter, pectinate, often crowded, sometimes interrupted, cell membrane rather thick, colourless, slightly undulated and constricted.

SIZE. Cells ·015–·018 mm.

Rabh. Alg. Eur. iii., 368. Kirch. Alg. Schl. 78.

On moist walls and naked ground.

Plate LXXI. fig. 3. Portions of threads of *Schizogonium murale* × 400 diam.

FAMILY VII. CHROOLEPIDEÆ.

Aerial algæ, coloured golden yellow, orange or red-brown, when dry often becoming greenish grey; more or less fragrant with the odour of violets. Threads articulate, variously branched, cell membrane thick, or somewhat thick, firm, almost cartilaginous, collected in minute tufts, or densely interwoven in a thin or thick tomentose stratum. Cell contents oily or granulose, either red, orange, or yellow brown, growing paler after death.

Propagation by zoogonidia, produced in proper cells (sporangia) which are terminal, or by prolification formed laterally. Zoogonidia oblong-oval, furnished at one extremity with two vibratile cilia.—*Rabh. Alg. Eur.* III., 371.

GEN. 69. **CHROOLEPUS.** *Ag.* (1824.)

Characters the same as given above for the family.

There appears to us no occasion or justification for the substitution of *Trentepohlia* for the above generic name as some authors have done.

The following is an abstract of the process of reproduction, as observed by Dr. Caspary. (*Flora, Sept.* 28, 1858). "The apical cell of the threads has often a globular or pulvinate appendage, of a highly refractive nature, furnished with transverse wrinkles, and frequently also with a protuberance at the top. The whole cavity of the cells is filled with granular matter, mostly of a brownish red colour, but it frequently happens that the inner granules only are brownish red, whilst the outer ones are green. The reddish brown granules seem to be oil drops A great number of the threads terminate with a globose much thickened cell, which subsequently becomes the mother cell of the zoospores This mother cell is rarely found in the middle of the threads. Occasionally, but still more rarely, the cell immediately under the mother cell elongates itself sideways and upwards into a thread. The mother cell of the zoospores, when it forms the terminal cell of the thread, bears a conical mass of gelatine, often of considerable size, which, however, is seldom on the crown of the cell, but usually at its side. In those mother cells in which the zoospores are about to escape a division of the contents into small oval cells is clearly perceptible, and at the side, or near the top, the wall is extended into a short papilla. The contents emerge in the form of a well defined vesicle, with the zoospores penetrating through the ruptured papilla, sometimes, however, no vesicle is formed. A few moments after emerging the vesicle bursts, doubtless by absorption of water, and the zoospores swim about in every direction. The remnants of the vesicle are of a gelatinous nature. The escape of the zoospores was observed from nine in the morning till four in the afternoon, and seems to depend not upon the influence of light, but solely upon the effect of moistening with water. The zoospores are very small, ·0035-·0033 mm. They are filled with reddish brown granular matter, the apex alone being free and hyaline; there are two cilia, about three or four times as long as the spore. The apex with the cilia is directed forwards. They rotate perpetually whilst swimming; their motion being so rapid as to prevent a clear view of them, except when stopped by some obstacle, or when their motion is becoming retarded. The cell is surrounded by a clear highly refractive border looking like gelatine, but which may be only an optical appearance. After continuing in motion for about an hour the zoospores become sluggish, sink, become globular, elongate themselves, and shortly a division of the cell takes place by a transverse septum. Some reddish brown granules usually remain behind in the empty mother cell, and in the remnant of the vesicle. Oftentimes some zoospores cannot emerge from the mother cell, and then they sometimes germinate in it. These observations were made on a variety of Chroolepus aureus. *Quart. Journ. Micro. Science,* VIII. (1860), p. 159.

Chroolepus aureus. (*Linn*). *Kutz. Tab.* IV., *t.* 93.

Golden red or orange. Threads either collected in small tufts, or spreading in a soft silky stratum, sometimes intricately and densely expanded and very much branched. Cells as long, or two to three times as long as their diameter.

SIZE. Cells ·01-·012 mm. diam. Zoosporangium ·02 × ·03 mm.

Eng. Fl. v., p. 380. Eng. Bot. ii., t. 2528. Harv. Man. 189. Mack. Hib. 246. Rab. Alg. Eur. iii., 371.

Conferva aurea, Dillw. Conf. t. 35.

Byssus aurea, Eng. Bot. i., t. 212. Lightf. Fl. Scot. p. 1002. Hull Br. Fl. 307. Relhan Cant. 446. Huds. Fl. Ang. 606. Sibth. Ox. 338. Purton Midl. Fl. ii., 606. Ray. Syn. 56, No. 6. Abbot Bedf. 276. With. Arr. iv., 144.

Ceramium aureum, Hook. Fl. Scot. ii., 86.

Amphicomum aureum, Johnst. Fl. Berw. ii., 243.

Trentepohlia aurea, Ag. Syst. p. 36.
Ectocarpus aureus, Lyngb. Hydro. Dan. t. 44. Grev. Fl. Ed. 315.

On walls, rocks, chips, bark, &c.

Plate LXXII. fig. 1. Portions of filaments × 400 *a*, zoosporangium; *b*, zoospore; *c*, same at rest; *d*, germinating zoospore.

Chroolepus odoratus. (*Lyngb.*) *Ag. Syst.* 35.

Stratum thin, rather tomentose, rufous-tawny (when dry cinereous, becoming greenish). Threads and branches abbreviated, erect, parallel, flexuously curved, torulose; cells equal or twice as long as their diameter.
SIZE. Cells ·02-·025 mm. diam.
Eng. Fl. v., 381. Harv. Man. 190. Rabh. Alg. Eur. iii., 372.
Conferva odorata, Lyngb. Hydr. Dan. t. 57. Johnst. Fl. Berw. ii., 245.

On the bark of various trees, especially of Birch and Poplar.

Plate LXXII. fig. 2. Portion of thread of *Chroolepus odoratus* × 400.

Chroolepus Iolithus. (*Linn.*) *Ag. Syst. p.* 34.

Stratum thin, or a line thick, reddish-orange, glaucous or dirty greenish when dry, threads and branches elongated, rather dichotomous, variously curved, ascending; cells one and a half or three times as long as their diameter, in the upper portion of the branches reaching to double that proportion.
SIZE. Cells ·025-·04 mm. diam. Zoosporangium ·05 mm. diam.
Eng. Fl. v., 380. Eng. Bot. ii., p. 189. Harv. Man. 189. Mack. Hib. 246. Rabh. Alg. Eur. iii., 373.
Byssus Iolithus, Linn. Spec. 1638. Hull. Br. Fl. 308.
Olivia violacea, Gray. Arr. i., 350.
Trentepohlia Iolithus, Wallr. Comp. iv. 151.

On rocks, in moist places.

Plate LXXII. fig. 4. Portion of thread of *Chroolepus Iolithus* × 400; *a*, zoosporangium × 400.

Chroolepus ilicicolus. *Eng. Bot.* II., *t.* 2529.

Filaments erect, alternately branched, forming tufts of a permanent tawny-yellow. Cells nearly as long as broad.
SIZE. Cells about ·03 mm. diam.
Conferva ilicicola, Eng. Bot. i., t. 1639.

Chroolepus aureus, Eng. Fl. v., 380, in part.

On Holly bark.

Included in Harvey's Manual (p. 189) under *Chroolepus aureus*. Figured from the original specimen.

Plate LXXII. fig. 5. Portion of thread of *Chroolepus ilicicolus* × 400.

Chroolepus lichenicolus. *Ag. Syst.* 34.

Tufts red-orange; threads erect, tufted, alternately branched, rigid; cells slightly tumid, as long as broad.

SIZE. Cells ·012 mm. diam. Zoosporangium about ·015 mm. diam.

Eng. Fl. v., 381. Eng. Bot. ii. t., 2530. Harv. Man. 190. Mack. Hib. 247.

Conferva lichenicola, Eng. Bot. i., t. 1609. Dillw. Conf. p. 56.

Chroolepus abietinum, Rabh. Alg. Eur. iii., 372, in part.

On Lichens and old trees.

Figured from the original specimens.

Plate LXXII. fig. 3. Portion of thread of *Chroolepus abietinum*, var. *lichenicolus* × 400.

Species Excluded.

Chroolepus Arnottii. *Harv. Man. p.* 191.

This is a fungus, *Antennaria Arnottii*, Berk in Herb.

Chroolepus ebenea. *Harv. Man. p.* 189.

Conferva ebenea, Dillw. Conf. t. 101.
Byssus nigra, Eng. Bot. i., t. 702.

Probably a species of *Helminthosporium*.

Chroolepus melaenus. *Carm. in Harv. Man. p.* 189.

Conferva melaena, Lyngb. Hydrot. 57.

Apparently a *Torula*.

Chroolepus mesomelas. *Carm. in Harv. Man. p.* 189.

Torula mesomela, Carm. Alg. App.

We have seen no specimen, but it would appear from description to be *Helminthosporium*.

Family VIII. CHÆTOPHORACEÆ.

Aquatic or swamp-living algæ, rarely terrestrial, monœcious or diœcious. Articulate filaments various, often dichotomously branched, not rarely fasciculately branched, accumulated in tufts or pulvinules, nestling in a somewhat fluid or firm gelatinous mucus, or constituting, for the most part, a filamentose, rarely a somewhat foliaceous thallus (formed from a single stratum).

Propagation by oospores after sexual fecundation, or by zoogonidia; the latter produced singly, or by the division of the cytioplasm, or contents of the sporangium, into eight or sixteen.

Genus 70. **MICROTHAMNION.** *Nag.* (1849.)

Articulate filament dichotomously or trichotomously branched, now and then very much branched, straight, with the terminal cell obtuse, or nearly so, afterwards swollen, forming a sporangium. Cell contents effused, containing scattered amylaceous granules. Propagation by zoogonidia. Plants microscopical, more or less with a gelatinous investment.

Microthamnion vexator. *Cke. in Grevillea* XI., *p.* 75.

Filaments erect, very slender, dichotomously branched, more or less growing in tufts. Cells cylindrical, longer than broad, not at all constricted at the joints, dissepiments scarcely visible. Cell membrane thin, pellucid.

Size. Cells about ·003 mm. diam.

Attached to aquatic plants in clear springs, &c.

A very delicate plant, first found by Mr. Turner in Yorkshire, and since detected in several localities in England. Very much more slender than *M. strictissimum*.

Plate LXXIII. fig I. Filaments of *Microthamnion vexator* × 400. *a*, tufts of plants natural size.

Genus 71. **STIGEOCLONIUM.** *Kutz.* (1843.)

Articulate threads simply branched, branches and branchlets scattered, rarely approximate in a fasciculate manner, acute at the apex, sometimes attenuated into a colourless bristle, at times extended very long, at other times furnished with shortly subulate branches. Cell membrane very thin and hyaline, homogeneous. Cell contents with the chlorophyll arranged in transverse bands.

Propagation by oospores or zoogonidia, the latter formed by division (4-16) of the cell contents, each zoospore furnished with a red parietal spot and four vibratile cilia.

Stigeoclonium thermale. *Braun in Kutz. Spec. p.* 352.

Bright green, very much branched in a fasciculate manner, somewhat creeping at the base, filaments and branches attenuated upwards to the cuspidate apex, branchlets for the most part alternate, rather remote, nearly erect or somewhat divergent, setiform, joints variable in length, at the base of the filaments equal or twice as long as the diameter, becoming turgid, in the upper part of the branchlets 3-5 times as long as the diameter; chlorophyllose bands broad, sometimes effused.

SIZE. Cells ·012 mm.

Rabh. Alg. Eur. iii., 376. Kutz. Tab. Phyc. iii., t. 2, f. 4.

Draparnaldia elongata, Hass. Alg. 123, t. 10, f. 3. Ann. Nat. Hist. Aug. 1842, xi., p. 4.

In thermal springs, &c.

Hassall found this species on one occasion growing in a horse-trough. It is sometimes mixed with other algæ in ditches.

Plate LXXIII. fig. 2. Filament of *Stigeoclonium thermale* with zoogonidia × 400 diam.

Stigeoclonium tenue. *Ag. Syst.* 57.

Bright green, lubricous; filaments a little branched, branches nearly simple, cells equal or 2-3 times as long as their diameter, more or less distinctly constricted; chlorophyllose bands narrow; branchlets scattered, shortened, nearly erect, subulate; cells at the base longer than broad, abbreviated towards the apex.

SIZE. Cells ·01 mm. diam.

Kutz. Tab. Phyc. iii., t. 3, f. 1. Rabh. Alg. Eur. iii., 377. Kirch. Alg. Schles. p. 68.

Draparnaldia tenuis, Eng. Fl. v., 388. Eng. Bot. ii., p. 199. Harv. Man. 122. Mack. Hib. 222. Hass. Alg. 123, t. 11, f. 2.

Conferva lubrica, Dillw. Conf. t. 57. Grev. Fl. Ed. 318. Hook. Fl. Scot. ii., 82. Gray Arr. i., 303.

Conferva exigua, Dillw. Conf. t. 2 (young).

In streams and ditches.

"At first the filaments are enclosed, in the manner of a *Chætophora*, in a common, somewhat definite gelatine; afterwards, on its bursting, they issue from it like a *Conferva*, but are at all times very gelatinous."—*Harvey*.

Plate LXXIII. fig. 3. Filament of *Stigeoclonium tenue* × 400 diam.

Stigeoclonium protensum. (*Dillw.*) *Kutz. Tab. Phyc.* III., *t.* 8, *f.* 2.

Pale green, cæspitose, slender; filaments and branches long drawn out; cells almost cylindrical, equal or twice as long as their diameter; terminal cell extended into a colourless bristle; branches usually scattered, rarely in pairs, with the extremities cuspidate, piliferous.

SIZE. Cells ·015 mm. diam.

Rabh. Alg. Eur. iii., 378.

Draparnaldia condensata, Hass. Alg. 122, t. 11, f. 1. Ann. Nat. Hist. xi., 429.

Conferva protensa, Dillw. Conf. t. 67. Gray. Arr. i., 303.

In slow streams.

Plate LXXIV. fig. 1. Filament of *Stigeoclonium protensum*. *a*, zoospores × 400 diam.; *b*, branchlet of form called *S. irregulare* × 400 diam.

Stigeoclonium nanum. (*Dillw.*) *Kutz. Spec. p.* 352.

Filaments alternately branched; branches abbreviated, a little attenuated upwards, obtuse, not piliferous; cells equal or a little shorter than their diameter, in the upper part equal.

SIZE. Cells ·008 mm. diam.

Rabh. Alg. Eur. iii., 380.

Draparnaldia nana, Hass. Alg. 124, t. 10, f. 3.

Draparnaldia sparsa, Hass. Ann. Nat. Hist. xi., 428.

Conferva nana, Dillw. Conf. t. 30.

In streams (the Wye).

The following are Dillwyn's remarks on this species:—"The minuteness of the filaments, which in length seldom much exceeded a line, prevented me from ascertaining their nature so fully as I could have wished. Their colour is pale brown, tinged with green, sub-diaphanous under the microscope. They appear to consist of a single stem, beset at uncertain distances with alternate branches, which are again clothed with short, simple, solitary ramuli, placed at small distances from each other, most commonly alternate, although sometimes two or more together are disposed on the same side. All of them are finely acuminated; the dissepiments are very apparent, and divide the filament into joints, all of equal size, of which the length is about double the thickness. To the naked eye this plant appears, when taken from the water, like a mere mass of decaying vegetable matter. Its extreme minuteness might fairly induce a suspicion whether it is in reality anything more than the seedling of some known Conferva. It adheres to either glass or paper."

Plate LXXIV. fig. 2. Filament of *Stigeoclonium nanum* × 400 diam., figured from Dillwyn's original specimen.

Stigeoclonium fastigiatum. (*Ralfs.*) *Kutz. Tab. Phyc.* III., *t.* 8, *f.* 1.

Pale green, small, thread very much branched, fastigiate, radiately disposed, mucous, upper branches alternate, fastigiate, moniliform, somewhat pinnate, a little spreading, extended at the apex in a long bristle; cells of the filament three times as long as broad, the branches equal or twice as long, swollen, constricted at the joints.

SIZE. Cells ·012 mm. diam.

Rabh. Alg. Eur. iii., 380.
Chætophora fastigiata, Ralfs. Alg. Exs., No. 9.

Attached to aquatic plants.

Plate LXXIV. fig. 3. Filament of *Stigeoclonium fastigiatum* × 400 diam.

GENUS 72. **DRAPARNALDIA.** *Ag.* (1824.)

Articulate thread simply branched, formed of large cells, for the most part hyaline, with a broad chlorophyllose band, always sterile; more or less densely furnished with penicellate fasciculate branchlets, alternate or opposite, composed of smaller fertile cells. Terminal cells of all the branches empty, hyaline and sterile, more or less elongated into a bristle.

Propagation by resting spores or zoogonidia.

Draparnaldia glomerata. *Ag. Syst. p.* 59.

Filaments and primary branches colourless, or nearly so; lower cells equal, or a little shorter than their diameter, distinctly constricted at the joints; chlorophyllose bands narrow, pale green, primary branches spreading at right angles, sometimes opposite; fascicles of the branches crowded, alternate or opposite, densely branched, obtuse, oval.

SIZE. Cells of main thread ·035 mm., of fascicles ·008 mm.

Eng. Fl. v., 388. Jenner Tunb. Wells 176. Eng. Bot. ii., t. 2545. Harv. Man. 121. Grev. Fl. Ed. 321. Mack. Hib. 222. Flor. Dev. ii., 50. Hook. Fl. Scot. ii., 77. Gray. Arr. i., 302. Hass. Alg. 120, t. 13, f. 1. Rabh. Alg. Eur. iii., 381. Kirch. Alg. Schles. p. 67. Kutz. Tab. Phyc. iii., t. 12.
Conferva mutabilis, Dillw. Conf. t. 12. Eng. Bot. i., t. 1746.
Batrachospermum conglomeratum, Vauch. Conf. t. 12, f. 1.

In clear pools or slow streams.

Very common, and well known. Variable in the size, number, and disposition of the fascicles.

Plate LXXV. fig. 1. Portion of filament of *Draparnaldia glomerata* × 400 diam. Fig. 2, portion of filament of the variety *distans* × 400 diam.

In 1857 Dr. Braxton Hicks first described in the "Journal of the Linnean Society" (Vol. i., p. 192) what he believed to be a new species of *Draparnaldia* under the name of *Draparnaldia cruciata,* of which we know nothing except from his description and figures, from which we are disposed to regard it as a variety of *Draparnaldia glomerata.* It was first found in the New Forest, and was more fully illustrated in the "Quarterly Journal of Microscopical Science" (Vol. ix., 1869, p. 383, pl. xix.). "Nothing," he says, "is more remarkable than the direction taken by the branches, which diverge strictly at right angles to the stem. Even the lesser kind, called tufts, and their branchlets, pass off in this way, and as four generally spring from the same joint, there is a cruciate arrangement in every part."

The following is given as its description:—" Frond 3-4 inches long. Light green colour, not so green as *D. glomerata* and *D. plumosa,* possessing a flocculent appearance when in water, and highly mucous when out of water. Every portion is surrounded by a distinct layer of transparent mucous, extending on each side to the distance of three diameters of the included ramulus. This is most easily seen after two days, when extraneous matter adheres to the mucous. The main filament is composed of cells very slightly inflated, 3-4 times longer than wide, about $\frac{1}{330}$th of an inch wide, delicately fasciated. Primary ramuli proceeding at right angles, chiefly in whorls of four, from the main filament, with an interval of 50-60 cells. The sub-ramuli also proceed in the same way from the primary ramuli, giving the plant a cruciate appearance. The cells of the ramuli as wide as long, the larger fasciated, the smaller quite filled with green chlorophyll. The interspace of 50-60 cells of main filament being great, to the naked eye it appears nearly bare, but by higher magnifying powers small tufts, like those terminating the sub-ramuli, appear at about every ten cells; some larger, and approaching somewhat the sub-ramuli, while the others are very simple. The larger terminal and lateral tufts have a pyramidal form, and from all their divisions proceeding at right angles it appears much like a fir tree. All the ultimate tufts bear cilia, as in the other *Draparnaldiæ,* but of extreme length and tenuity. From the 1-3 basal cells of the ramuli often roots spring, coiling themselves round the main filament, and even spreading away from it, and sometimes the free point becomes converted into a tuft, like those on the main filament. The smaller tufts at times possess them. When the plant is mature the ramuli disengage themselves, and can be seen floating about with their roots, probably ready to attach themselves to any suitable object, and so become separate plants. Zoospores not so large as in *D. glomerata,* being oval, and about ·0004 × ·0003 inch. A whole tuft undergoes the process simultaneously."

" It can easily be distinguished from *D. plumosa* and *D. glomerata* by the divisions diverging at right angles, and in whorls of chiefly four (giving the cruciate appearance), the perceptible mucous sheath, exceeding delicacy of the cilia, extreme tendency to give out radicles, the nearly equal width of the main cells, as also their greater length. The fir tree-like form of the tufts are so unlike the flexible shape of the other species."

A comparison of the plate given with the description we are bound to say does not completely bear out all the distinctions.

Draparnaldia plumosa. (*Vauch.*) *Ag. Syst. p.* 58.

Threads and primary branches hyaline, cells equal or shorter than their diameter, rarely a little longer, a little, or but scarcely constricted at the joints, chlorophyllose bands narrow, bright green, lower cells of the branches equal or almost twice as long as their diameter, upper cells cylindrical, attenuated, 2-5 times as long as broad, sometimes not piliferous, fascicles of the branches densely branched, elongated, with an acutely lanceolate outline, erect, somewhat appressed.

SIZE. Cells of main thread ·045 mm., of fascicles ·008 mm.

Eng. Fl. v., 388. Eng. Bot. ii., t. 2544. Harv. Man. 121. Johnst. Fl. Berw. ii., 258. Mack. Hib. 222. Flor. Dev. ii., 50. Hook. Fl. Scot. ii., 77. Gray Arr. i., 303. Hass. Alg. 121, t. 12, f. 1. Rab. Alg. Eur. iii., 382. Kirch. Alg. Schles. p. 67. Kutz. Tab. Phyc. iii., t. 14.

Conferva lubrica, Eng. Bot. i., t. 2087.

In slow streams or pools.

Much less common than the preceding species.

Plate LXXVI. fig. 1. Portion of filament of *Draparnaldia plumosa*, × 400. *Fig.* 2. Portion of filament of the variety *pulchella* × 400.

GENUS 73. **CHÆTOPHORA.** *Schrank.* (1789.)

Articulate filaments, with the primary branches radiately disposed, composed of elongated vegetative cells, with chlorophyll bands as in *Draparnaldia* and *Stigeoclonium*; divided upwards into numerous branchlets, which are shortly artoculated, the ultimate joint attenuated, often empty, scarcely or not at all lengthened into a thread, ultimate branchlets in more or less crowded fascicles, involved in a firm gelatinous, coriaceous, or hard mass, of a globose or subglobose, or plane, expanded, variously lobed form. Propagation the same as in the preceding genera.

Chætophora pisiformis. (*Roth.*) *Ag. Syst. p.* 27.

Thallus globose, about the size of a pea, often smaller (now and then as large as a cherry), bright green, even, shining, sometimes aggregated, not rarely confluent.

SIZE. Cells ·006-·009 mm., of branches ·006 mm.

Hass. Alg. 128, t. ix., f. 5, 6. Kutz. Tab. Phy. iii., t. 18, fig. 3. Grev. Sc. Crypt. Fl., t. 150. Rabh. Alg. Eur. iii., 383. Kirch. Alg. Schl. p. 69. Eng. Fl. v., 389. Harv. Man. 123. Berk. Glean. t. 1, f. 1.

Ulva pisiformis, Huds. Fl. Ang. 572. With Arr., iv. 120. *Chætophora elegans*, Lyngb. Hydro. t. 65.

On submerged plants.

Plate LXXVII. fig. 1. Plants of *Chætophora pisiformis*, natural size, and filaments × 400.

Chætophora tuberculosa. (*Roth.*) *Ag. Syst.*

Thallus subglobose, the size of a cherry, bright or pale green, surface tuberculose, elastic, fascicles of branches very dense, lower articulations cylindrical, the upper swollen, extremities cuspidate, sharp pointed, rarely hair-like.

SIZE. Cells ·009-·012 mm., of branches ·008-·01 mm.

Harv. Man. p. 122. Hass. Alg. 126, t. 9, f. 7, 8. Kutz. Tab. Phyc. iii., t. 19, f. 1. Rabh. Alg. Eur. iii., 383. Eng. Fl. v., 389. Jenner Tunb. Wells p. 178. Eng. Bot. ii., t. 2547. Johnst. Fl. Berw. ii., 260. Mack. Hib. 223. Hook. Scot. ii., 76. Kirch. Alg. Schles. p. 69.

Rivularia tuberculosa, Eng. Bot. i., 2366.

In clear water.

Plate LXXVIII. fig. 1. *a*, plant of *Chætophora tuberculosa*, natural size. *b*, filaments of same × 400 diam.

Chætophora elegans. (*Roth.*) *Ag. Syst.*

Thallus the size of a pea or a cherry, pale green, surface even, elastic, soft, now and then becoming hard, fascicles of branches lax, rather flaccid, extremities shortly cuspidate, often terminating in a hair.

SIZE. Cells ·007-·009 mm., of branches ·005-·007 mm.

Kutz. Tab. Phyc. iii., t. 20, f. 1. Rabh. Alg. Eur. iii., 384. Kirch. Alg. Schl. p. 69. Eng. Fl. v., 389. Jenner Tunb. Wells 178. Mack. Hib. 223. Harv. Man. 122. Grev. Fl. Ed. p. 321. Hass. Alg. 127, t. 9, f. 3, 4.

Rivularia elegans, Eng. Bot. i., t. 1797. Purton Mid. Fl. ii., 618.

In clear water, attached to submerged plants.

Paler in colour, and more hyaline and gelatinous than *C. pisiformis*.

Plate LXXVII. fig. 2. *a*, plants of *Chætophora elegans* natural size. *b*, zoogonidia. *c*, filament × 400.

Chætophora endivæfolia. *Ag. Syst. p.* 28.

Thallus linear, flattened, ½-1 inch, now and then elongated, bright or dark green, dichotomously laciniate (sometimes with the habit of *Riccia fluitans*), threads and primary branches mostly colourless, here and there with green zones, parallel;

fascicles of branches lateral, more or less dense, spreading articulations more or less swollen, nearly equal in length and diameter, constricted at the joints, cell contents granulose, effused.

SIZE. Cells ·01-·015 mm., of branches ·008-·011 mm.

Kutz. Tab. Phy. iii., t. 21, f. 2. Rabh. Alg. Eur. iii., 385. Kirch. Alg. Schl. p. 70. Eng. Fl. v., 389. Eng. Bot. ii., t. 2546. Harv. Man. p. 122. Johnst. Fl. Berw. ii., 261. Mack. Hib. p. 222. Hook. Fl. Scot. ii., p. 76. Hass. Alg. 125, t. 9, f. 1, 2.

Batrachospermum fasciculatum, Vauch. Conf. p. 116, t. 13.

Ulva incrassata, Eng. Bot. i., t. 967. Huds. Fl. Ang. ii., 572. With. Arr. iv., 124.

Conferva gelatinosa Damæ cornu, Ray Syn. p. 60.

Tremella gelatinosa Dama cornuum, Dill. Musc. 51, t. 10, f. 10.

Rivularia incrassata, Purton Mid. Fl. iii., p. 179.

Myriodactylon endivæfolium, Gray Arr. i., 302.

In ditches, &c.

Exceedingly variable in the form of the thallus, and hence divided into 7 or 8 varieties.

Plate LXXVIII. fig. 2. *a*, plants of *Chætophora endivæfolia*, natural size. *b*, portion of filament × 400 diam.

Chætophora punctiformis. *Kutz. Tab. Phyc. iii., p.* 4, *t.* 18, *f.* 2.

Echinella articulata, Eng. Bot. ii., t. 2555.

Conferva echinata, Eng. Bot. i., t. 1378.

Assuming that Mr. W. Phillips (Grevillea ix., p. 5) is correct in the presence of globose basal spores, this will have to find a place in *Rivularia*, and not in *Chætophora*.

GENUS 74. COLEOCHÆTE. *Bréb.* (1844.)

Articulated filaments branched, either united in a pulvinule, or little cushion, or expanded in a flat, somewhat disc-shaped parenchymatous thallus ; cells oblong, more or less dilated in front, sometimes bearing from the back or upper surface a hyaline bristle, which is sheathed at its base.

Propagation by oospores resulting from sexual fertilization, and by zoogonidia. Zoogonidia single in the fructiferous cells, either globose or broadly oval, furnished with two vibratile cilia.

The Coleochæteæ are small discoid Algæ, from 1 to 2 mm. in diam., bright green colour, constructed of branched rows of cells. They are found attached to submerged plants in stagnant or slow-moving streams, and form circular, closely-pressed discs. The chlorophyll is in parietal plates or large granules. Some of the cells bear colourless erect bristles fixed at the base in narrow sheaths.

Reproduction takes place by means of asexual zoogonidia, and sexually produced oospores. The latter do not at once produce new plants, but several zoospores. The zoospores, which are developed in the early part of the year from resting-spores of the previous year, produce only asexual plants which only form zoogonidia. After a series of asexual generations, of variable length, a sexual generation arises, which according to the species is monœcious or diœcious. Fertilization produces one oospore in the oogonium, which developes into a reproductive body, from the cells of which zoospores proceed in the next period of vegetation. Zoogonidia may originate in all the vegetative cells of the Coleochæteæ, and are always formed from the entire contents of the mother-cell, escaping through a round hole in the cell wall.

"In *C. pulvinata* the terminal cell of a branch swells up, and at the same time elongates into a narrow sac, which then opens, and exudes a colourless mucilage. The protoplasm of the swollen part, which contains chlorophyll, forms the oospore, in which a nucleus is visible. The antheridia are formed at the same time in adjoining cells, two or three protuberances growing out, which become separated by septa; each of the cells thus formed, which have somewhat the shape of a flask, is an antheridium; its entire contents form an antherozoid of oval shape with 2 cilia, which is endowed with motion like a zoogonidium; its entrance into the oogonium has not yet been observed. The effect of a fertilization is seen in that the contents of the carpogonium become surrounded with a proper membrane and form the oospore."

Coleochæte soluta. *Prings. Jahrb. t.* 1, *f.* 2.

Threads radiating from a common centre, furcately branched, of equal length, closely packed side by side, prostrate, but not connate, forming an orbicular disc. Cells one and a-half to three times as long as broad, oogonia placed before the terminal cells, globose, corticate.

SIZE. Cells ·025 mm.

Rabh. Alg. Eur. iii., 389. Kirch. Alg. Schles. p. 50.

Attached to aquatic plants.

Plate LXXVIII. fig. 3. Plant of *Coleochæte soluta* × 400. *a*, Oogonium × 250 diam.

Coleochæte scutata. *Bréb. Ann. Sci. Nat.*, 1844, *p.* 29, *t.* 2.

Filaments and their branches radiating from the centre, very densely connate in one stratum, forming a kind of parenchymatous orbicular disc; cells quadrangular, nearly equal or twice as long, oogonia subglobose, peripherical, corticate above, naked below.

SIZE. Cells ·02-·022 mm.

Rabh. Alg. Eur. iii., 390. Hass. Alg. 217, t. 77, f. 6. Prings. Jahrb. t. i., f. 4; t iii., f. 3, 4.

Phyllactidium setigerum, Kutz. Tab. Phyc. iv.

On aquatic plants.

Plate LXXIX. Coleochæte scutata. a, plant × 200. *b*, portion with oogonia. *c*, portion with antheridia cells. *d*, zoospore, active and at rest. *e*, development of young plants.

Coleochæte orbicularis. *Prings. Jahrb. t.* 1, *f.* 5.

Disc orbicular, parenchymatous, formed from one stratum of cells, bright green, cells oblong-quadrangular when old, by pressure becoming often polygonal, usually twice as long as broad. Oogonia oval, peripherical, mostly naked.

SIZE. Cells ·012-·017 mm.

Rabh. Alg. Eur. iii., 390. Kirch. Alg. Schles. p. 50.

Phyllactidium pulchellum, Kutz. Tab. Phyc. iv.

On aquatic plants.

Plate LXXX. fig. 1. *a*, plant × 200. *b*, portion with oogonia, after Pringsheim × 250.

GENUS 75. **APHANOCHÆTE.** *Braun.* (1847.)

Articulate threads prostrate, somewhat creeping, sometimes more or less united in an irregular stratum. Branches decumbent or ascending, cells bearing on their apex or back, often a long bristle which has no sheath at the base. Propagation by zoogonidia. Oogonia at present unknown.

Aphanochæte repens. *Braun Rejuv. p.* 184.

Filaments and branches procumbent, adpressed; cells slightly swollen, of equal diameter in both directions, supporting an indistinctly articulated bristle.

SIZE. Cells ·005-·01 mm.

Rabh. Alg. Eur. iii., 391. Kirch. Alg. Schles. p. 71.

On *Cladophora flavescens*, and other Algæ.

Plate LXXX. fig. 3. Plant of *Aphanochæte repens* × 400.

Aphanochæte hystrix. (*Thw.*) *Rabh. Alg. Eur.* III. 391.

Filaments and their branches radiating, procumbent, adpressed; more or less connate, in a pale green irregular discoid thallus. Cells somewhat cylindrical, produced at the apex into a long bristle, which is not articulated.

SIZE. Cells ·01 mm. diam.

Ochlochæte hystrix, Thwaites in Harv. Phyc. Britt. t. 226.

On aquatic plants in brackish ditches.

Perhaps scarcely deserving a place here, as it is almost, if not quite, a marine species.

Plate LXXX. fig. 2. *a*, plant of *Aphanochæte hystrix*, slightly magnified. *b*, portion more highly magnified, after Harvey.

APPENDIX

TO CHLOROPHYLLOPHYCEÆ.

In the form of an Appendix we shall here enumerate a few species, of doubtful position, which are not known with sufficient exactitude to be recorded in systematic order, although their affinities appear to be with the Algæ. The *Saprolegnieæ* are not included, because they are now generally acknowledged as Fungi. The genus *Synchitrium* also appears to be more nearly related to *Protomyces*, amongst Fungi, than to Algæ.

Family. CHYTRIDIEÆ.

Plants for the most part aquatic, parasitic, epiphytal or endophytal, occasionally epizoic, very rarely terrestrial, one or two-celled. Cells vesiculose, single or gregarious, either innate in the fostering plant, or penetrating its membrane; furnished with radicles at the base, or destitute of them; now and then numerous and densely aggregated, involved in a common membrane, nestling in the parenchyma of terrestrial plants, and forming pustules. Protoplasm mucilaginous, usually colourless, sometimes coloured. Antheridia not yet observed. Propagation by oospores or zoogonidia.

Some authors have united the majority of the species under the one genus *Chytridium*, whilst others have distributed them over several genera, as *Chytridium*, *Phlyctidium*, *Rhyzophidium*, *Olpidium*, and *Rhizidium*, but apparently without good reason.

Genus 76. **CHYTRIDIUM.** *Braun.* (1851).

Cells globose or somewhat pear-shaped, operculate above, the root-like base usually innate in various algæ, penetrating the membrane of their cells.

Zoogonidia very numerous, globose, with a nucleus, bearing a single very long cilium, escaping through the orifice of the cell caused by the falling away of the operculum.

"The *Chytridia* form a genus of unicellular, parasitical Algæ, or, if it be preferred, of aquatic Fungi, related to *Saprolegnia* about as much as *Ascidium* is to *Bryopsis*. The entire plant is composed of a single balloon-shaped cell, which penetrates into the Algæ upon which it grows, by a more or less developed root-like base. The inflated portion of the cell is filled with colourless mucilage, from which are formed, not through successive division, but by a simultaneous process, very numerous small globular germ-cells, which exhibit a sharply-defined darker nucleus in the interior, and possess a single very long cilium. From their want of colour and the activity of their motion these gonidia resemble the most minute monads. Their extrusion occurs either through the casting off of a lid or through mere tearing of a nipple-shaped point. Of fifteen different species which I have observed in the vicinity of Freiburg, *Chytridium olla* is the largest, and at the same time exhibits the lid-like dehiscence most beautifully. It grows on the anterior wrinkled end of the bulging parent-cells of the spores of *Œdogonium Landsboroughii*, the root penetrating into the folds and attaching itself to the spore. The free inflated portion of the cell is ovate, with the lid somewhat thrown up at the edges, and apiculated like a short nipple in the middle. The germ-cells are about ·003 mm. diam."—*Braun, Rejuvenescence*, pp. 186 *note*.

See also Braun, "Ueber Chytridium" (Berlin, 1856); Cohn in "Hedwigia," 1865, p. 170; Nowakowski "Beitrag zur Kenntniss der Chytridiaceen' (Breslau, 1876).

Chytridium acuminatum. *Braun Chytr. p.* 28, *t.* 1, *f.* 11.

Cells much smaller than in *Chytridium olla*, ovate-pyriform; operculum acuminate.

SIZE. Cells ·016 mm. long.

Rabh. Alg. Eur. iii., p. 277.

Parasitic on species of *Œdogonium.*

Plate LXXXI. fig. 1. *Chytridium acuminatum* parasitic upon *Œdogonium Rothii* × 400 diam.

GENUS 77. **RHIZOPHYDIUM.** *Schenk.* (1858.)

Cells globose, ovate, or broadly clavate, with 2, 3, or more scattered orifices, more or less elongated into a neck, furnished with, or destitute of, distinct radicles at the base.

Rhizophydium Barkerianum. (*Archer.*) *Rabh. Alg. Eur.* III. 281.

Cells much depressed, 3 or 4 lobed, the lobes broadly rounded; upper surface of the cell concave, bearing at the centre a vertical hyaline, very slender, terete, minutely capitate process; cell contents mainly confined to the centre, leaving the ends of the lobes empty; zoospores making their exit through the opened apices of the lobes.

Chytridium Barkerianum, Archer in Quart. Journ. Micr. Sci. 1867, p. 89.

Parasitic on *Zygnema.* Callery Bog (Ireland).

We have seen no specimens, and are not aware of any figure extant, or of any dimensions having been recorded.

GENUS 78. **OLPIDIUM.** *Braun.* (1856.)

Cells globose or subglobose, parasitic, epiphytal, or endophytal, not operculate, nor rooting; mouth vertical, elongated into a cylindrical tube.

Olpidium endogenum. *Braun Chytrid. No.* 20, *t.* v., *f.* 21.

Parasitic in the interior of plants, usually gregarious, depressedly globose, extended at the apex into a tubular neck, which is globosely dilated in the middle; perforating the membrane of its host, is extended beyond with a funnel-shaped mouth.

SIZE. Cells about ·024 mm. diam.

Olpidium intestinum (Braun), Rabh. Alg. Eur. iii., 283.

Parasitic in *Closterium, Vaucheria,* &c.

This appears to be the species figured by Henfrey as occurring within the cells of *Eremosphæra viridis* in "Quart. Journ. Micr. Sci." vii. (1859), t. 3, figs. 11, 12. Also by Carter in *Spirogyra,* in "Annals of Natural History," 2nd Series, Vol. xvii. (1856), t. 9, figs. 9 and 10.

Plate LXXXI. fig. 2. *Olpidium endogenum* parasitic in *Closterium lunula* × 400.

Olpidium ampullaceum. (*Braun.*) *Rabh. Alg. Eur.* III., 282.

Epiphytal, gregarious, globose, small, sessile, rarely pedicellate, tubular, mouth erect, cylindrical, about as long as the cell, terminating in a conical apiculus.

SIZE. Cells ·0065 mm. diam.

Chytridium ampullaceum, Braun Chytrid., p. 66, t. 5, f. 24-27.

Parasitic on various algæ.

It was probably this, or a closely-allied species, which was figured by Henfrey as parasitic on *Eremosphæra viridis* in "Quart. Journ. Micr. Sci." vii. (1859), t. 3, f. 13, 14.

Plate LXXXI. fig. 3. *Olpidium ampullaceum* parasitic on *Mougeotia* × 400; 3*a*, individual further magnified. Fig. 4, allied species × 400.

GENUS 79. **SYNCHITRIUM.** *D.By. & Wor.* (1863.)

Thallus multiform. Cells (sporangia of some authors) often numerous and aggregated, closely involved in a common membrane, forming sori, filled with delicately granular orange contents. Zoogonidia globose, rarely oval or oblong, with a lateral orange-red nucleus, bearing a single (rarely 2) very long cilium.

Inhabiting the substance of plants, with the habit of Uredines, but without mycelium.

Synchitrium Taraxaci. *D. By. & Wor. Bericht. der Naturf. Ges. Freiburg* III., *t.* 2, *f.* 1-7.

Orange warts, about ·5 mm. diam., prominent on both surfaces of the leaf, scattered or crowded. During summer each wart contains a mass of crowded cells, polygonal or rounded, variable in form and size, filled with granular orange protoplasm, which break up into globose, ciliated zoogonidia.

SIZE. Zoogonidia ·003 mm. ; cellules ·02-·06 mm. diam.

Parasitic beneath the cuticle of living leaves of dandelion (*Taraxacum officinale*).

Professor Trail adds to the above description that "in the autumn thicker-walled resting spores are formed singly in the cells of the food plant."

Plate LXXXI. fig. 5. Sorus of *Synchitrium Taraxaci* × 200. Figs. 6, 7, cells with contents converted into zoogonidia, × 400. Fig. 8, free zoogonidia, × 400 ; after Woronin.

Synchitrium anemones. *Woron. Bot. Zeit.* XXVI., *p.* 100, *t.* 2, *f.* 8-10.

Forming dark violet, or almost black, hemispherical warts, the size of a pin's head, which are gregarious, and sometimes confluent. In the centre of each is a sphærical cellule, the wall of which is dark brown and warted.

Dothidea anemones, DC. Fl. Fr. vi., 143.
Sphæronema anemones, Libert. Crypt. Ard., No. 167.
Septoria anemones, Fuckel Fung. Rhen., No. 518.
Chytridium ? anemones, D.By. & Wor. Beitr. p. 29.

Parasitic on the leaves of *Anemone nemorosa*.

Plate LXXXII. fig. 7. Portion of leaf with *Synchitrium* nat. size. Fig. 8, persistent spore-cell *in situ* × 200. Fig. 9, persistent spore-cell free × 320 ; after Woronin.

Synchitrium mercurialis. *Fckl. Fungi Rhen., No.* 1067.

Tubercles confluent on the nerves of the leaves, hemispherical, greenish, depressed above; umbilicated; sori oblong, grey, zoogonidia globose, uninucleate, hyaline.

SIZE. Sporangia echinulate ·03-·04 mm.

Schrœt. in Cohn's Beitr. p. 40. Grevillea ii., p. 162.

Parasitic on leaves of *Mercurialis perennis*. April.

Plate LXXXII. fig. 1. Section of wart with persistent spore-cell. Fig. 2, persistent cell. Fig. 3, same with contents polygonally divided. Fig. 4, sporangia escaping × 160. Fig. 5, sporangia × 320. Fig. 6, free zoospores × 320 ; after Woronin.

GENUS 80. **CHLOROCHYTRIUM.** *Cohn.*

Plant endophytic; green, unicellular; cells globose, or somewhat irregularly bi-, tri-, or multi-lobed; densely filled with chlorophyll, first dividing into large segments, and then these giving origin to innumerable pyriform zoospores, which escape through a tubular process.

Chlorochytrium Lemnæ. *Cohn. Beitr.* I., 87.

The zoospores, impinging on the epidermis of the duckweed at the junction of two cells, after germination commences a tube is produced, which, entering between the walls of the dissepiments, proceeds as far as the mesophyllic parenchyma, growing into the intercellular spaces, and forms either a globose, elongated, or irregular-shaped cell.

SIZE. Adult cell 0-·1 mm. diam.

Wright in Trans. Roy. Irish Acad. xxvi. (1877), p. 13. Archer in Quart. Journ. Micr. Sci. xv. (1875), p. 104.

Living in the thallus of *Lemna trisulca.* Westmeath (Ireland).

Cohn says of this species: "Its zoospores attach themselves to the thallus of the duckweed often in hundreds. They force their way through between the epidermal cells, assuming, as the foremost portion gets into the hypodermal tissues, a more or less figure of eight-shaped form: the foremost portion, getting into an intercellular space, dilates; the portion that has not entered remains unexpanded, and forms a colourless nipple-like projection; the portion within the thallus expands to many times its original diameter, sometimes dilating and filling up an intercellular space, at others distorting the subadjacent cellular tissue, and frequently itself becoming variously distorted. The cell wall becomes thicker, even laminated; the chlorophyll contents get dark and dense, and the cell becomes of a dark, nearly opaque green; sometimes starch granules are seen. The cell contents become segmented, breaking up into a number of pear-shaped zoospores, which escape through the nipple-like projection; their actual exit was not seen, nor was the number or position of the cilia observed. Of the zoospores, many never succeeded in penetrating the epidermis of the duckweed upon which they alighted, and such would remain as minute colourless pin's heads on the surface of the Lemna. Some would linger within the mother cell, and might possibly be resting spores."—*Abstract by Prof. Perceval Wright, loc. cit.*

Plate LXXXI. fig. 9. *Chlorochytrium Lemnæ* parasitic on duckweed. Zoospores located in intercellular spaces × 600. Fig. 10, in a more advanced stage × 600. Fig. 11, free zoospores × 600. After Cohn.

CLASS II. PHYCOCHROMOPHYCEÆ.

Plants one or many celled, living in water, or enclosed in a maternal jelly when out of it, mostly in families formed from successive generations of cells. Cell membrane (*Cytioderm*) not siliceous, combustible. Cell contents (*Cytioplasm*) a brown, olivaceous, or fuscous endochrome, destitute of nucleus, and usually without starch granules.

Propagation by division, and by immovable gonidia, or quiescent spores.

ORDER I. *CYSTIPHORÆ.*

Unicellular plants. Cells sphærical, oblong, or cylindrical enclosed in a tegument, associated in families surrounded by a universal tegument, immersed in a more or less liquid or firm mucilage, variable in colour, for the most part irregularly disposed. Division of the cells taking place in one, two, or three directions alternately. Propagation by quiescent gonidia.

Fœcundation unknown.

FAMILY I. CHROOCOCCACEÆ.

Thallus mucous or gelatinous, amorphous, enclosing cells and families irregularly disposed.

It may be urged that, as many of the species included in this family, as well as in the analogous *Palmellaceæ*, are only conditions of higher forms, they should not have been inserted. In the preparation of a Flora of this kind, however, we are of opinion that whilst the life history of these forms is so imperfectly known, we should not have been justified in excluding them.

GENUS 81. **CHROOCOCCUS.** *Nägeli.* (1849.)

Cells globose, or more or less angular from mutual pressure, solitary, or associated in globose cubical or amorphous families, free (not involved in a mother-cell). Cell membrane in most cases thin, homogenous, achromatic, often confluent in a more or less firm jelly ; cell contents verdigris, or pallid blue green, not rarely yellow or orange. Propagation by division alternately in three directions.

Chroococcus cohærens. *Näg. fide Rabh.*

Cells oblong, twin, or in fours, with a distinct hyaline ellipsoid tegument; cell-membrane thin, achromatic; cell-contents homogenous, or slightly turbid, blue-green.

SIZE. Cells ·003-·006 mm. diam. Families of 2-4 individuals.

Rabh. Alg. Eur. ii., 30. Kirch. Alg. Schles. 261.

Protococcus cohærens, Kutz. Spec. 197. Tab. Phyc. 1, t. 5.

Pleurococcus cohærens, Breb. in Meneg. Nost. Ital. 35, t. iv., f. 3.

On damp walls and flower pots.

Plate LXXXIII. fig. 1. Cells magnified 400 diam.

Chroococcus turgidus. *Näg. Einz. Alg. p.* 46.

Cells sphærical, oblong-ellipsoid, or more or less angular from compression, single, twin, ternate, or quaternate (rarely 8), associated in families, tegument thick, usually evidently lamellose, colourless. Cell-membrane thin; cell contents bright verdigris green and homogenous, at length becoming brownish and granulated.

SIZE. Cells ·013-·025 mm. diam. Families of 2-4.

Rabh. Alg. Eur. ii., 32. Kirch. Alg. Schles. p. 262.

Protococcus turgidus, Kutz. Tab. i., t. 6, f. 1.

Hæmatococcus binalis, Hass. Alg. p. 331, t. 82, f. 2.

In swampy places and on moist rocks.

Not at all uncommon; often mixed with other algæ. Easily distinguished by its size.

Plate LXXXIII. fig. 2. Cells magnified 400 diam.

GENUS 82. **GLŒOCAPSA.** *Kutz.* (1843.)

Cells sphærical, either single or numbers, associated in families, the single cell included in a vesiculiform tegument, this cell undergoing division into two daughter cells. Each has a distinct tegument, the whole being surrounded by the tegument of the mother cell. This process is repeated again and again, the original tegument remaining and surrounding the family thus formed. Cell membrane thick, often very thick, equalling or exceeding in diameter the cavity of the cell; colourless or coloured, mostly lamellated, strata not unfrequently separating. Cell contents of various colours, æruginous, bluish green, steel-blue, reddish, yellowish, fuscous, &c. Division of the cells in three directions, the last generation of the cells smaller than the early ones.—*Rabh. Alg. Eur.* ii., 34.

Glæocapsa coracina. *Kutz. Phyc. Gen.* 174, *t.* 6, *f.* 1.

Thallus crustaceous, very black, lubricous; single cells sphærical, small, tegument very pale violet, distinctly lamellose, cell contents homogenous blue-green.

SIZE. Cells ·0033-·004; with envelope ·006-·014 mm. Families ·009-·075 mm. diam.

Rabh. Alg. Eur. ii., 35. Kirch. Alg. Schles. p. 258.

Microcystis atrovirens, Meneg. Nost. Ital. 76, t. 10, f. 1.

On rocks, and on boggy ground amongst moss.

Plate LXXXIII. fig. 3. Cells magnified 400 diam.

Glæocapsa atrata. (*Kutz.*) *Rabh. Alg. Eur.* II., 35.

Thallus crustaceous, mucous, black; cells sphærical small, tegument very thick, hyaline, homogenous, two or three times broader than the central cell, cell-contents pale verdigris green, rather granulated.

SIZE. Cells ·0035-·0045 mm., with envelope ·009-·014 mm. Families ·01-·08 mm.

Nag. Einz. Alg. t. 1, f. 1. Kirch. Alg. Schles. p. 258.

Microcystis atra, Kutz. in Linn. viii., 375.

On rocks in mountain regions.

Plate LXXXIII. fig. 4. Cells magnified 400 diam.

Glæocapsa livida. (*Carm.*) *Kutz. Tab.* I., *t.* 21, *f.* 5.

Thallus mucous, rounded lobate, broadly expanded hyaline dingy green, or olive brownish, cells very minute, tegument pale bluish, hyaline, cell contents solid dark blue-green.

SIZE. Cells ·003-·006 mm.; with envelope ·006-·0078 mm. Families ·016-·05 mm.

Rabh.Alg. Eur. ii., 36. Kirch. Alg. Schles. 258.

Palmella livida, Carm. in Grev. Fl. Edin.; Eng. Fl. v., 397. Harv. Man. 178.

Hæmatococcus lividus, Hass. Alg. 332, t. 82, f. 5.

Microcystis livida, Meneg. Nost. 74, t. 9, f. 2.

On naked ground, or amongst moss and lichens, rarely on rocks, on mountainous moors.

"Covers the overhanging limestone rocks to a great extent, sometimes as much as several hundred yards together. When fresh it looks like a blackish brown, gelatinous substance, giving the rocks on which it grows the appearance of being covered with pitch ; on places where it becomes dry by exposure to the sun it is very friable, and on being touched crumbles down to a powder."—*Moore, in Hass. loc. cit.*

Plate LXXXIII. fig. 5. *Glæocapsa livida,* drawn from Carnuchael's original specimen × 400.

Glæocapsa caldariorum. *Rabh. Alg. Eur.* 37.

Thallus irregular thick gelatinous, pale yellowish, cells solitary, globose or rather elliptical, tegument sphærical or elliptic, colourless lamellose, lamellæ often diffuse, the externally one manifestly diffluent; cell-contents homogenous, or rather granulose, pale blue-green.

SIZE. Cells ·003-·006 mm. with envelope ·019-·04 mm.

Glæocapsa montana var. *caldarii*, Suringar Obs. 54, t. 4, f. E. Kirch. Alg. Schles. 257.

On walls, flower-pots, glass, &c., in conservatories and greenhouses.

Plate LXXIII. fig. 6. Cells magnified 400 diam.

Glæocapsa polydermatica. *Kutz. Tab.* 1, *t.* 20.

Thallus gelatinous, more or less compact, dirty green, or olive becoming brownish; cells small sphærical, tegument very thick, hyaline lamellose, lamellæ numerous, concentric, firm; cell-contents verdigris green, almost homogenous.

SIZE. Cells ·003-·0045 mm.; with envelope ·023 mm. Families ·05 mm.

Rabh. Alg. Eur. ii., 37. Kirch Alg. Schles. 257.

Microcystis rupestris, Meneg. Nost. 72, t. 9, f. 1.

Hæmatococcus rupestris, Hass. Alg. 326, t. 82, f. 1.

On moist rocks.

"Frond hyaline, gelatinous, yellowish green, easily broken up, about an inch in diameter, shapeless, rough, pellucid, more or less dense in the centre and elevated; when dried collapsed, blackish, cartilaginous, fragile. Subjected to the microscope it appears constituted of hyaline subsphærical vesicles, enclosing yellowish green, spherical or slightly oblong globules usually undivided. Solitary globules, magnified with glasses less powerful are seen free and naked; by means of a more powerful microscope, almost all are perceived to be clothed with a proper cyst, larger vesicles enclose smaller, and the whole frond appears areolated, the hollow areolæ containing solitary or binate globules. The vesicles general as well as partial, duplex, triplex, or multiplex, and that without any perceptible order, commonly present concentric circles, generally approximated, evident to the light."—*Meneghini.*

Plate LXXXIII. fig. 7. Cells magnified 400 diam.

Glæocapsa quaternata. *Kutz. Tab.* I., *t.* 20, *f.* 1.

Thallus mucous, effused, dirty green, becoming reddish brown; cells usually sphærical, single or twin or quaternate (rarely 6-8) in families, tegument narrow, lamellose, achromatic, rounded or oblong; cell-contents verdigris green, homogenous, or delicately granulated.

SIZE. Cells ·0032-·0045 mm.; with envelope ·007-·011 mm. Families ·011-·022 mm.

Rabh. Alg. Eur. ii., 37. Kirch. Alg. Schles. 257.

Coccochloris quaternata, Breb. MSS.

On rocks or moist ground (Scotland).

Plate LXXXIII. fig. 8. Cells magnified 400 diam.

Glæocapsa arenaria. (*Hass.*) *Rabh. Alg. Eur.* I., 39.

Thallus mucous, cohærent, somewhat olive-coloured; cells large sphærical, tegument thick oblong or almost sphærical, colourless, lamellose; lamellæ diffluent, cell-contents verdigris green then brownish, distinctly granulated.

SIZE. Cells ·0033-·005 mm., with envelope ·006-·014 mm. Families ·04 mm.

Rabh. Alg. Eur. ii., 39.

Hæmatococcus arenarius, Hass. Alg. 330, t. 76, f. 10.

In springs and thermal waters.

Plate LXXXIV. fig. 1. Cells magnified 400 diam.

Glæocapsa æruginosa. (*Carm.*) *Kutz. Tab.* I., *t.* 21, *f.* 2.

Thallus crustaceous, grumous, or cartilaginous, glaucous green; cells small sphærical, tegument thick colourless, indistinctly lamellose, externally not rarely angular, cell-contents verdigris green, homogenous.

SIZE. Cells ·0022-·003 mm. with envelope ·0044-·0088 mm. Families ·016-·05 mm.

Rabh. Alg. Eur. ii., 39. Kirch. Alg. Schles. 258.

Palmella æruginosa, Carm. MSS.

Hæmatococcus æruginosus, Hass. Alg. 333, t. 82, f. 3.

On limestone and other rocks.

Plate LXXXIV. fig. 2. Cells and families magnified 400 diam.

Glæocapsa magma. (*Breb.*) *Kutz. Tab.* I., *t.* 22, *f.* 1.

Thallus grumous, rather crustaceous, purple brown, blackish when dry; cells for the most part sphærical, tegument lamellose intense purple or coppery-brown, usually not pellucid, external stratum very broad, globose, paler or colourless, soon diffluent; cell-contents verdigris green, granulose, often becoming brownish.

SIZE. Cells ·0045-·007 mm., with envelope ·006-·012 mm.

Rabh. Alg. Eur. ii., 42. Kirch. Alg. Schl 259.

Sorospora montana, Hass. Alg. 309, t. 79, f. 1.

Palmella montana, Ag. Syst., p. 18. Eng. Fl. v., 396. Eng. Bot. ii., t. 2554. Harv. Man. 179.

Protococcus magma, Meneg. Nost. p. 43.

Ulva montana, Lightf. Fl. Scot. 973. Hull. Br. Fl. 314. Eng. Bot. i., t. 2193. Hook Scot. ii., 91. With. Arr. iv., 122.

Merrettia alpicola, Gray Arr. i., 349.

"Mountain dulse," of the Scotch.

On moist rocks.

"On the mountains of Arran, this lies unattached among loose wet stones, covering them in a straggling manner to a considerable extent. Each frond is 1-1½ inch. in diameter, flattish, somewhat orbicular, between coriaceous and gelatinous, when dry almost horny, of a deep but dull purple colour, much lobed and curled like some *Gyrophoræ*, filled with crowded clusters of granules, which, if minutely examined are found to be mostly arranged in fours."—*Hooker*.

In Scotland it is called Mountain Dulse, and, according to Lightfoot, "the Highlanders wash it and rub it between their hands into some water, so as to make a thin pulpy mixture, with which they purge their calves."

Plate LXXXIV. fig. 3. Cells and families magnified 400 diam.

Glæocapsa rupicola. *Kütz. Spec. p.* 221.

Thallus black, then fuscous or brown, crustaceous, thin, rather grumous, cells small, sphærical, tegument narrow, not lamellose, fuscous then rusty-brown, for the most part associated in fours, rarely in twos; outer tegument broad, very pale, globose, enclosing numerous smaller families, soon diffluent; cell-contents pale verdigris green, or rusty brown.

Size. Cells ·0033-·005 mm. Families ·07 mm.

Rabh. Alg. Eur. ii., 43.

On rocks amongst moss (Scotland).

Plate LXXXIV. fig. 4. Cells and families magnified 400 diam.

Glæocapsa sanguinea. (*Ag.*) *Kutz. Tab.* I., *t.* 22.

Thallus effused, gelatinous, thin, blood red or thicker and somewhat crustaceous, then becoming blackish brown; cells of medium size, sphærical, tegument intense blood red, not lamellose, in the middle pale red, the extreme outer colourless or nearly so, very broad, globose or angular; cell-contents pale verdigris green, granulose.

Size. Cells with envelope ·0037-·009 mm. Families to ·14 mm.

Rabh. Alg. Eur. ii., 43. Kirch. Alg. Schles 259.
Palmella sanguinea, Ag. Syst. p. 15.
Hæmatococcus sanguineus. Ag. Icon. t. 24. Harv. Man. p. 181. Hass. Alg. 329, t. 79, f. 2. Eng. Fl. v., p. 395.

On rocks.

Plate LXXXV. fig. 1. Cells and families magnified 400 diam.

Glæocapsa Ralfsiana. (*Harv.*) *Kutz. Tab.* I., *t.* 23.

Thallus gelatinous, compact, dark purple brown; cells of medium size, sphærical, tegument very thick, opaque, and intense purple, the outer very broad, usually angular from mutual compression, almost colourless, rarely diffluent, enclosing smaller families of 2, 4, 6, 8; cell-contents granulated, pale verdigris green.
Size. Cells with envelope ·01-·017 mm. Small families ·022-·04 mm. Large families, to ·17 mm.
Rabh. Alg. Eur. ii., 44.
Sorospora Ralfsii, Hass. Alg. 310, t. 79, f. 3.
Palmella Ralfsii, Harv. Man. 179.

Amongst moss and lichens.

"Thallus a few lines in diameter, gelatinous, somewhat areolate, or as if composed of numerous small vesicles massed together, each of which contains 2·4 or 8 large blood red granules, which are much larger and of a far deeper colour than those of *G. magma.*"—*Harvey.*

Plate LXXXV. fig. 2. Cells and families magnified 400 diam.

Glæocapsa Shuttleworthiana. *Kutz. Tab.* I., *t.* 23, *f.* 1.

Thallus gelatinous, rather hard, compact, dark rufous brown; cells small sphærical, tegument very thick, many times broader than the central cell, globose, intense orange red, the outer globose or angular, homogenous, pale orange, or (rarely) colourless, all, except the inner, soon diffluent; cell-contents pale verdigris green.
Size. Cells with envelope ·0075-·013 mm. Families ·035 mm.
Rabh. Alg. Eur. ii., 44. Kirch. Alg. Schles. 259.

On moist rocks, and amongst moss.

Plate LXXXV. fig. 3. Cells and families magnified 400 diam.

Glæocapsa rupestris. *Kutz. Tab. Phyc.* I., *t.* 22, *f.* 11

Thallus dark brown, crustaceous, rather hard; cells rather large, sphærical; tegument very thick, lamellose, yellow or golden brown, the outer permanent, yellowish or becoming pale ; cell-contents verdigris green, granulose.

SIZE. Cells ·006-·009 mm. with envelope. Families ·015-·075 mm.

Rabh. Alg. Eur. ii., 47. Kirch. Alg. Schles. p. 260.

On rocks.

Plate LXXXIV. fig. 5. Cells and families magnified 400 diam.

GENUS 83. **APHANOCAPSA,** *Näg.* (1849.)

Cells spherical, with a thick, soft, colourless tegument, confluent in a homogenous mucous stratum. Cell division as in *Glœocapsa.—Rabh. Alg. Eur.* II., 48.

Aphanocapsa virescens. (*Hass.*) *Rabh. Alg. Eur.* II., 248.

Thallus gelatinous, more or less expanded, dirty green, or olive, becoming brownish, cells of medium size, pale bluish-green, solitary or in pairs, tegument scarcely visible. Cell contents homogenous, sometimes with a central vacuole.

SIZE. Cells about ·0055 mm. diam.

Sorosporium virescens, Hass. Alg. 310, t. 78, f. 8 *a*.

Aphanocapsa parietina, Nag. Einz. Alg. t. 1*b*, f. 1.

On stones, rocks, &c.

Plate LXXXVI. fig. 1. Cells magnified 400 diam.

Aphanocapsa rivularis. (*Carm.*) *Rabh. Alg. Eur.* II., 49.

Thallus hemispherical, gelatinous, tuberculose, often confluent, æruginous-green, becoming brownish when dry ; cells spherical, scattered, single or in pairs, tegument very thick, not lamellose, colourless, soon diffluent. Cell-contents bluish-green, delicately granular.

SIZE. Cells about ·005-·006 mm. diam.

Palmella rivularis, Carm. MSS. Harv. in Hook. Eng. Fl. v., p. 397. Harv. Man. 177.

Coccochloris rivularis, Hass. Alg. 317, t. 78, f. 6 *a*, *b*.

On rocks and stones inundated, in mountain streams.

"Fronds one-fourth or half an inch in diameter, hemispherical, tubercular, firmly adhering, sometimes cohering into a broad crust. Colour vivid green."—*Carmichael.*

Plate LXXXVI. fig. 2. Cells of *A. rivularis*, × ·400.

Aphanocapsa Grevillei. (*Hass.*) *Rabh. Alg. Eur.* II., 50.

Thallus gelatinous, globose, densely aggregated, more or less confluent, dirty green, from olive to brownish when dry ; cells sphærical or elliptic, rather crowded, single or in pairs, nestling in a homogenous jelly, tegument quickly diffluent, cell-contents blue-green, delicately granulose.

SIZE. Cells ·0035-·006 mm. diam.

Kirch. Alg. Schles. 261.

Coccochloris Grevillei, Hass. Alg. 318, t. 78, f. 7 *a*, *b*, 8.

Palmella botryoides, Grev. Crypt. Fl. t. 243, f. 2. Eng. Fl. v., 396. Eng. Bot. ii., p. 207. Grev. Fl. Ed. 323. Mack. Hib. 244.

Palmella Grevillei, Berkl. Glean. p. 16, t. v., f. 1. Harv. Man. 177.

Botrydina Grevillei, Meneg. Nost. p. 47.

Byssus botryoides, Huds. Ang. 608. Lightf. Fl. Scot. p. 1006. Rehl. Cant. 447.

Cocochloris radicata, Johnst. Fl. Berw. ii., 262.

Olivia botryoides, Gray Arr. i., 349.

Byssus pulverulenta viridis, Dillen. Musc. 3, t. 1, f. 5.

Byssus botryoides saturate virens, Ray. Syn. 56, No. 5.

On damp heaths and moors.

Plate LXXXVI. fig. 3. *a*, natural size; *b*, cells magnified 400 diam.

Aphanocapsa depressa. (*Hass.*) *Rabh. Alg. Eur.* II., 51.

Thallus somewhat hemispherical, depressed, gelatinous, green. Cells sphærical or irregular, variable in size.

SIZE. Cells ·0025-·003 mm.

Palmella depressa, Berk. Glean. 19, t. 5, f. 4. Harv. Man. 178.

Coccochloris depressa, Meneg. Nost. 68. Hass. Alg. p. 316, t. 78, f. 4 *a*, *b*.

Growing on an old pump, at Cotterstock, Northamptonshire, constantly moistened with the drippings from the spout.

"Fronds bright yellow-green, gelatinous, subhemispherical, depressed, crowded together, filled with more or less globose or angular very minute granules."—*Berkeley*.

Plate LXXXVI. fig. 4. *a*, plant natural size; *b*, cells magnified 400.

GENUS 84. **MICROCYSTIS.** *Kutz.* (1833.)

Cells sphærical, numerous, densely aggregated, enclosed in a very thin globose mother vesicle, forming solid families, singly, or several, surrounded by a universal tegument. Cell division in three directions alternately.

This genus as defined by Rabenhorst (*Alg. Eur.* II., 51) not appearing to differ essentially from *Anacystis*, both are united in this work.

Microcystis protogenita. (*Bias.*) *Rabh. Alg. Eur.* II., 51.

Thallus membranaceous, thin, green; families small, angular from mutual pressure; cells small, sphærical; cell-contents granular, pale blue-green.

SIZE. Families, ·02 mm. Cells, ·0015-·002 mm.

Micraloa protogenita, Bias. Alg. Micr. t. xix. Meneg. Nost. t. xiv., fig. 1 (partly).

In water long standing, stagnant ditches, amongst other Algæ, &c.

Plate LXXXVI. fig. 5. Families magnified 400 diam.

Microcystis marginata. (*Meneg.*) *Kirch. Alg. Schl.* 255.

Thallus sphærical, flattened, or orbicular and lens-shaped, sometimes confluent, pale-green, colourless at the margin; cells minute; cell contents blue-green, at length granular.

SIZE. Cells ·003-·004 mm. Families ·8-·03 mm.

Anacystis marginata, Meneg. Nost. 93, t, 13, f. 1, Rabh. Alg. Eur. ii., 52.

In ditches, free swimming.

Plate LXXXVI, fig. 6. Families magnified 400 diam.

GENUS 85. CLATHROCYSTIS. *Henfrey.* (1856.)

Frond, a microscopic gelatinous body, at first solid, then saccate, ultimately clathrate (fragments of the broken fronds occurring in irregularly lobed forms) composed of a colourless matrix, in which are imbedded innumerable minute cells, which multiply by division within the frond as it increases in size.—*Quart. Journ. Micr. Sci.*, 1856, p. 53.

Clathrocystis æruginosa. *Henf. Micr. Journ.* 1856, *p.* 53, *t.* 4, *f.* 28-36.

Fronds floating in vast strata on freshwater pools, forming a bright green scum, presenting to the naked eye a finely granular appearance; when dried, appearing like a crust of verdigris; cells minute.

SIZE. Fronds ·03-·13 mm.; cells ·0025-·0035 mm.

Rabh. Alg. Eur. ii., 54. Kirch. Alg. Schles. 254.

Microcystis æruginosa, Kutz. Tab. i., t. 8.

Polycystis æruginosa, Kutz. Spec. 210.

On fresh water lakes.

"The smallest fronds met with are usually roundish or ellipsoidal. When quite young they appear to be solid, but as they grow by the multiplication of the internal cells and the secretion of gelatinous matter, the expansion takes place chiefly near the periphery, so that the frond becomes a hollow body. The walls of the sac then give way, and, as the expansion proceeds, orifices are formed in different parts, until the whole becomes a coarsely latticed sac or clumsy net of irregularly lobed form. Then this becomes broken up into irregular fragments of all shapes and sizes (giving the stratum a granular appearance to the naked eye), each of which recommences the expanding growth, and becomes a latticed frond. The internal cells are very minute, but have a distinct margin with internal granules. They multiply by dividing into two and four. The gelatinous frond always presents a transparent border or peripheral stratum, destitute of green cells; but no boundary membrane exists, the surface exhibiting a softened or half-dissolved aspect. On the approach of winter the fronds ceased to increase, and by degrees most of the gelatinous masses faded to a light brownish tint, swelled up and settled to the bottom of the water in light flocculent clouds. They appear to become half-dissolved, and to allow the green cells to become free, as many of the latter were found free, adhering to the sides of the vessel. Perhaps these reproduce the fronds in the next season. No zoospores were ever detected."—*Henfrey.*

Clathrocystis roseo-persicina, Cohn., is already included in this work, as *Pleurococcus roseo-persicinus*, pl. 2, fig. 6.

Plate LXXXVI. fig. 7. *a*, Thalli magnified 200 diam.; *b*, cells magnified 400 diam.

GENUS 86. **CŒLOSPHÆRIUM.** *Näg.* (1849.)

Thallus globose, small, vesicular, hollow, composed of small cells, which are associated in families at the periphery, immersed in a mucous stratum, formed from the speedily confluent teguments. Increase by division of the cells in all directions.

Cœlosphærium Kutzingianum. *Näg. Einz. Alg. p.* 54, *t.* 1 *c.*

Families sphærical. Cells subglobose, geminate, or quaternate, loosely disposed; cell-contents blue-green, delicately granulose.

SIZE. Cells ·002-·005 mm.; families ·06 mm. and more.

Rabh. Alg. Eur. ii., 55. Quart. Journ. Micr. Sci. 1869, p. 197. Kirch. Alg. Schles. 254.

In ponds, meres, &c.

Plate LXXXVII. fig. 1. Families magnified 400 diam.

GENUS 87. **GOMPHOSPHÆRIA.** *Kutz.* (1836.)

Cells wedge-shaped, peripherical, 2-4-8 associated in radiating families nestling in jelly, covered with a tegument, and forming a solid globose free-swimming thallus. Cells dividing alternately in three directions.

Gomphosphæria aponina. *Kutz. Tab.* I., *t.* 31, *f.* 8.

Thallus microscopical, blue-green, often becoming pale, tegument colourless, rather thick and somewhat lamellose, central cells smaller, cell-contents verdigris or pale blue-green.

Size. Cells ·004 mm. diam. to ·01 mm. long; families ·05 mm.
Rabh. Alg. Eur. ii., 56. Kirch. Alg. Schles. 255.

In ditches.

Plate LXXXVII. fig. 2. Families magnified 400 diam.; *a, b, c, d,* cells in various stages of subdivision, further magnified—after Reinsch.

Genus 88. **MERISMOPEDIA.** *Meyen.* (1839.)

Cells globose, at the time of division oblong, rather thick, teguments confluent, 4-8-16-32-64-128 associated in tabular families of a single stratum, forming a quadrate, plane, free-swimming thallus.

Goebel has observed the formation of zoospores in this genus. See "Botanische Zeitung," 1880, p. 490.

Merismopedia violacea. *Kutz. Spec.* 472.

Thallus mucous, colourless, or nearly so, indefinite, families small, composed of 4-32 remote very minute cells; cell-contents homogenous, violet.
Size. Cells ·001-·0015 mm.; families ·015 mm.
Rabh. Alg. Eur. ii., 57. Kirch. Alg. Schles. 254.

In ponds, ditches, &c., amongst other Algæ.

Plate LXXXVII. fig. 3. Families magnified 400 diam.

Merismopedia glauca. *Nag. Einz. Alg. t.* 1, *D.* 1.

Thallus more or less limited, glaucous green, margin slightly sinuately crenate; families composed of 16-48-64 (rarely more) oval or globose cells; cell-contents pale blue-green.
Size. Cells ·003-·005 mm.; families ·04-·05 mm.
Rabh. Alg. Eur. ii., 56. Kirch. Alg. Schles. 253.
Gonium glaucum, Ehrb. Infus. 56, t. 3, f. 5.

In stagnant water.

Plate LXXXVII. fig. 4. Families magnified 400 diam.

Merismopedia punctata. *Meyen in Wirgm. Arch.* 1839, *p.* 67.

Thallus less limited, almost colourless, for the most part composed of 4-64 remote cells; cell-contents pale blue-green.
Size. Cells ·033 mm.; families ·06 mm.
Kutz. Tab. i., t. 38, f. 3. Rabh. Alg. Eur. ii., 57. Kirch. Alg. Schles. 254.

In stagnant water.

Plate LXXXVII. fig. 5. Families magnified 400 diam.

Merismopedia ventriculi. *Robin Veg. Par. t.* 1, *f.* 8.

Thallus mucous-membranaceous, firm, whitish or yellowish; families composed of numerous cells (8-4096); cell-contents pale bluish.

SIZE. Cells ·008 mm. diam.; families ·03-·05 × ·016-·02 mm.

Rabh. Alg. Eur. ii., 58. Kuchenm. Par. p. 13, t. 1.

Merismopædia Goodsiri, Husem. de Anim. p. 13.

Sarcina ventriculi, Goodsir in Edin. Med. and Surg. Journ. 1842, p. 430, t. 57. Welcker in Quart. Journ. Micr. Sci. viii., p. 163.

In the human stomach, &c.

Doubtfully included here. Recently authors have classed it with *Schizomycetes* in preference to Algæ.

Plate LXXXVII. fig. 6. *a*, cells magnified 400, *b*, cells very highly magnified. After Robin.

Merismopedia renis. (*Hepw.*) *Rabh. Alg. Eur.* II., 59.

Families composed of from 8 to 64 cells.

SIZE. No dimensions given.

Sarcina renis, Hepworth in Micr. Journ. v. 1857, p. 1, with woodcut.

In the human kidneys.

This very obscure organism, like the last, is included here with considerable doubt. It may be said that nothing more is known of it than the meagre diagnosis above given. *Sarcina ossium*, Stephens, Ann. Nat. Hist. ser. 2, vol. xx., p. 514, is equally uncertain.

Plate LXXXVII. fig. 7. Cells very considerably but indefinitely magnified. After Hepworth.

GENUS 89. **TETRAPEDIA.** *Reinsch.* (1867.)

Cells compressed, quadrangular or triangular, equilateral, becoming subdivided into quadrate or cuneate segments, or rounded lobes, either by deep vertical or oblique incisions, or by wide angular or rounded sinuses.

"Amongst unicellular Algæ falling under the class *Chlorophyllaceæ*, forms with specially figured cells—that is, otherwise than globular, ellipsoidal, or cylindrical, with more or less abruptly or broadly rounded ends—are, as is well known, numerous; but amongst such plants belonging to the class *Phycochromaceæ*, so frequently found in the same situations associated with the foregoing, so far as I am aware, not until recently has attention been drawn to any examples of a specially figured outline.

"It does not appear, until the genus Tetrapedia was founded by Professor Reinsch for two new and singular exceedingly minute chroococcaceous forms, that examples of specially figured forms were known in this family of Algæ.

"So far as our acquaintance with these little Algæ reaches, there appear to exist four (if not five) distinct, yet kindred forms of *figured* 'Chroococcaceæ'—their remarkable shapes preclude their being regarded as 'Lichen-gonidia,' but whether mature plants or stages in the growth of any more complicated structure remains a problem. Ours are at least forms which here and there recur, and one can at once recognise them as always offering the same charactersitics and as maintaining their apparent individuality. Whether they are 'species' or not, it may be a matter of convenience, should observers meet them elsewhere, and be able to throw a light upon them, to have at least a means of their recognition; for these reasons it occurs to me as desirable to record them under Reinsch's genus."—*W. Archer in Grevillea* I., *p.* 44.

Tetrapedia Crux-Michaeli. *Reinsch Alg. Mitt. Frank.*

Cells quadrate, lateral margins entire, with two shallow concavities, each extending half the length of the side, thus producing an obtuse-angled central prominence, deeply incised at the angles, incisions diagonal, rectilineal, deep, acute below, slightly expanding upwards, thus bisecting the angles, and dividing the cell into four broadly cuneate segments, the upper angles of which are subacute (the incisions ultimately completed, and the cell breaking up?) ; in side view lanceolate, ends acute.

SIZE. Cells ·008-·012 mm. diam.

Archer in Grevillea i., p. 45. Reinsch Algenflora, t. i., fig. 6.

In running water (very scantily) near Mullingar,. Co. Westmeath, Ireland.

Plate LXXXVII. fig. 8. Cells magnified 600 diam.

Tetrapedia Reinschiana. *Archer in Grevillea* I., *p.* 46, *t.* 3, *f.* 11-13.

Cells quadrangular, two opposite margins excavated by a wide triangular sinus, thus subdividing the cell into two broadly cuneate segments connected by a wide isthmus, and somewhat convex on their lower margins ; the other two opposite margins of the cell, that is the upper margins of the segments, very slightly concave at the middle, somewhat raised towards the acute outer angles; in side view oblong, constricted at the middle, ends rounded.

SIZE. Largest cell ·0075-·01 mm. diam.

In moor pools, Co. Dublin and Wicklow.

Plate LXXXVII. fig. 9. Cells magnified 600 diam.

Tetrapedia setigera. *Archer in Grevillea* I., *p.* 46, *t.* 3, *fig.* 14-17.

Cells triangular, the lateral margins somewhat deeply excavated by a broad rounded sinus dividing the cell into three lobes, rounded at the ends, and each terminated by a very delicate straight bristle, in length about equal to the diameter of the cell; in side view oblong, somewhat inflated at the middle at each side, ends round, and each seen tipped by the bristle.

SIZE. Cells without bristles ·0062-·0075 mm., including the bristles ·016-·02 mm., from end to end.

In moor pools, Co. Dublin and Wicklow.

Plate LXXXVII. fig. 10. Cells magnified about 600 diam. After Archer.

GENUS 90. **SYNECHOCOCCUS.** *Näg.* (1849.)

Cells oblong, usually single, sometimes 2-4 connected in a series constituting a family. Cell membrane thin, cell-contents blue green; now and then yellow or pale orange. Tegument absent. Division in one direction only.

Synechococcus crassus. *Archer Micr. Journ.* 1867, *p.* 87.

Cells broadly elliptic, about one half longer than broad; cell wall very thin.

In shallow pools. Bray's Head, Ireland.

Larger than the largest of Nägeli's species (S. *æruginosus*), from which it is also distinguished by its elliptic or egg-shaped cells, somewhat narrowing towards the gradually rounded ends, and not cylindrical, with rounded truncate ends.

No figures or measurements of this species have been published, and only the bare description reproduced above.

GENUS 91. **GLŒOTHECE.** *Näg.* (1849.)

Cells cylindrical-oblong, rounded at the ends; division transversal in one direction. Other characters as in *Glœocapsa.* Tegument very thick, lamellose.

Glœothece cystifera. (*Hass.*) *Rabh. Alg. Eur.* II., 61.

Cells oblong-cylindrical, 2-4 associated in families; involved in a special universal tegument which is globose or oval, 1½-3 times as long as broad. Cell-contents verdigris green.

SIZE. Cells ·004-·005 mm., with tegument ·008-·012 mm. Families ·025-·045 mm.

Kirch. Alg. Schles., 251.

Coccochloris cystifera, Hass. Alg. 441, t. 103.

Glœothece devia, Nag. Einz. Alg., t. 1, f. G. 3.

On rocks.

Plate LXXXVIII. fig. 1. Cells and families magnified 400 diam.

Glœothece granosa. *Rabh. Alg. Eur.* II., 61.

Thallus compact-gelatinous, somewhat cartilaginous, granulose, blue-green; cells oblong, twice as long as broad, usually 2-4 associated in families; tegument very broad, many times exceeding the central cell, distinctly lamellose, colourless or nearly so, lamellæ scarcely diffluent; cell contents homogenous or granose, pallid blue-green.

SIZE. Cells ·014-·018 mm. diam.

Palmella granosa, Berk. Glean. ii., p. 19, t. 5, f. 5.

Microcystis granulosa, Meneg. Nost. 85.

Hæmatococcus granosus, Hass. Alg. 327, t. 81, f. 6. Jenner Tunb. Wells, 90. Harv. Man. 181.

On mosses in swamps.

Plate LXXXVIII. fig. 2. Cells and families magnified 400 diam.

GENUS 92. **APHANOTHECE.** *Nag.* (1849.)

Differing from *Glœothece* in all the teguments being usually confluent. Cells oblong or subcylindrical. Cell-contents now and then green, and then with difficulty distinguished from *Palmella*.

Aphanothece prasina. *Br. in Rabh. Alg. No.* 1572.

Thallus gelatinous, more or less globose, tuberculose, the size of a cherry, intense bright leek-green, sometimes confluent, and then lobed, internally now and then interwoven with hyaline threads; cells oblong or ovoid, 1-2 times longer than broad, after division sphærical, tegument none, cell-contents verdigris green.

SIZE. Cells ·005-·006 × ·008-·011 mm.

Rabh. Alg. Eur. ii., 65. Kirch Alg. Schles. 252.

Coccochloris stagnina, West and Wall. Herb. Belg. 1099.

Aphanothece Mooreana, Lager. Sver. Algflora p. 44.

Palmella Mooreana, of this work p. 12, t. 5, f. 4.

In ditches and stagnant ponds.

We are of opinion that this and the next species, as well as the *Palmella Mooreana* figured on the 5th plate of this work, are all one species.

Plate LXXXVIII. fig. 3. *a*, natural size; *b*, cells magnified 400 diam.

Aphanothece stagnina. (*Spr.*) *Rabh. Alg. Eur.* II., 66.

Thallus gelatinous, oblong or elliptical, or nearly globose, from the size of a pea to that of a cherry, pale hyaline verdigris green; cells oblong-oval, always smaller than in *A. prasina*, $\frac{1}{2}$-1 times longer than broad, tegument none, cell-contents pallid verdigris green.

SIZE. Cells ·003-·005 × ·005-·008 mm.

Kirch. Alg. Schles. 252.

Coccochloris stagnina. Spreng. Linn. Syst. iv., p. 372.

In stagnant water.

It is very doubtful whether any definite specific character can be found to separate this from *A. prasina*. As we have taken both from the same pond, the difference in colour, and in the size of the cells, may be assumed to be attributable only to difference in age.

Plate LXXXVIII. fig. 4. *a*, natural size; *b*, cells magnified 400 diam.

GENUS 93. **HOMALOCOCCUS.** *Kutz.* (1863.)

Thallus globose, gelatinous; internal cells irregularly united in a plane, oblong body, immersed in the gelatinous thallus.

Homalococcus Hassallii. *Kutz. Osterprog.* 1863, *p.* 6.

Thallus globose, soft, green, of the size of a pea or a hazelnut; cells rounded or somewbat angular.

SIZE. Cells about ·006-·007 mm. diam.

Rabh. Alg. Eur. ii., 69.

Coccochloris hyalina, Hass. Alg. 315, t. 78, f. 2, *a*, *b*.

In stagnant water.

Plate LXXXVIII. fig. 5. *a*, natural size; *b*, cells magnified 400 diam. After Hassall.

ORDER II. *NEMATOGENÆ.*

Plants multicellular, or pseudo-multicellular. Cells forming a filament (*Trichome*), usually included in a tubular homogenous or lamellate sheath (*vagina*). Filaments (*Trichomes*) either simple or branched.—*Rabh. Alg. Eur.* II., 70.

Thuret unites *Cystiphoræ* and *Nematogenæ* in one order under the name of *Cryptophyceæ*, representing the *Cystiphoræ* by a Tribe called *Chroococcaceæ* and *Nematogenæ* by another Tribe termed *Nostochineæ*, so that really the difference is only one of name.

TRIBE 1. **NOSTOCHINEÆ.**

Trichomes simple or branched, with an obtuse, or acute and setiform apex, either naked or enclosed in a sheath. Reproduction by fragments of the trichome (*hormogonia*) which are endowed with motion after separating from the mother plant =*Hormogoneæ*. Thuret.

The *Nostochineæ*, as interpreted by Messrs. Bornet and Thuret, are subdivided into two groups, or sub-tribes.

Sub-Tribe 1. PSILONEMÆ with the filaments not attenuated at one extremity to a hair-like thread.

Sub-Tribe 2. TRICHOPHOREÆ with the apex of the filament attenuated to a hair-like extremity.

Whilst the Chroococcaceæ reproduce themselves by means of isolated cells, the Nostochineæ reproduce themselves by the fragments of filaments (called *hormogones*), which are endowed with mobility after separating themselves from the mother plant.

The filaments of *Nostochineæ* are composed essentially of coloured cells disposed in a row. This assemblage of cells is especially designated a *trichome*. The trichome is either naked, or immersed in mucilage, or enclosed in a sheath.

The presence or absence of *heterocysts*, their number, their situation in the filament, are characters important to note, but which hitherto have been much neglected. Easily recognized in the living plant by their yellow colour from the other cells of the trichome, but sometimes difficult to distinguish in dried specimens. In doubtful cases it is to be remembered that the heterocysts are united always with the sheath, and if that envelope is defective in the other cells it will suffice to apply an appropriate re-agent, such as potass, solution of iodine, &c., to obtain evidence of their nature.

Sometimes the terminal cells of the trichome resemble the others (as in *Lyngbya* and *Scytonema*), sometimes the filaments are terminated by a hyaline hair, elongated and deprived of its coloured contents, with a diameter much less than the ordinary joints of the trichome (as *Calothrix*, *Rivularia*, &c.). This distinction, which corresponds in another instance to the principal growing point of extension of the filaments, is very marked in the living state, and especially in individuals in full vegetation. When, on the contrary, the plants are old, and the summit broken and their hormogones dispersed, the complete filaments are sometimes very rare, and must be sought with some perseverance.

Certain genera of *Nostochineæ* have the filaments constantly simple (*Nostoc*, *Anabaena*), others have the filaments frequently provided with lateral branches (*Scytonemeæ*, *Calotricheæ*). Sometimes these ramifications are normal, and result from the regular division of the trichome (*Rivularia*, &c.), sometimes accidental and irregular. These produce themselves when the trichome has broken, they grow and issue laterally from the sheath, when it is not rare to observe the base of the filaments of certain *Lyngbya*, or, again, when the hormogones are not able to escape freely, they germinate in the interior of the sheath. Indeed, it is very frequent that the germinations develope themselves in filaments of all ages, but in that case the young filaments are not at all enveloped by the general sheath of the filament that bears them.

Nostocs should be dried as quickly as possible after they are collected, otherwise the trichomes escape and the sheaths are left empty.—*Thuret*, in *Ann. des Sci. Nat.* 6 *ser.*, *Vol.* I., *pp.* 372-382 (1875).

The following is a dichotomous key to the classification as proposed by M. Thuret:—

1	Filaments tapering at the top into a hyaline hair	12
	Filaments always destitute of an apical hair	2
2	Filaments in which some of the cells change into heterocysts	3
	Filaments without heterocysts	7
3	Filaments with lateral ramifications	10
	Filaments without ramifications	4
4 NOSTOCEÆ	Filaments immersed in a gelatinous mucilage of a determinate shape	*Nostoc.*
	Filaments free or immersed in an amorphous diffluent mucilage	5
5	Filaments consisting of a coloured trichome enclosed in a hyaline sheath	6
	Filaments without a sheath distinct from the trichome	A. B. C.

1. *Heterocysts scattered in the trichome.*

A. Spores originating in cells not adjoining the heterocysts	*Anabaena.*
β Trichomes united in small floating bundles	*Aphanizomenon.*
B. Spores originating in cells placed on each side of the heterocysts	*Sphærozyga.*

2. *Heterocysts terminal* (*at both ends of the trichome*).

C. Spores originating in cells placed just below the heterocysts	*Cylindrospermum.*

6	Cells disc-like. Spores very prominent. Heterocysts placed at regular intervals	*Nodularia.*
	Cells longer than broad. Spores none	*Microchæte.*
7 LYNGBYEÆ	Filaments spirally twisted	*Spirulina.*
	Filaments not spirally twisted	8

8 Filaments without a sheath distinct from the trichome . . . . *Oscillaria.*
β Filaments agglutinated in small floating bundles . . . . . . *Trichodesmium.*
Filaments formed of one or several coloured trichomes enclosed in a transparent sheath, from which the trichomes emerge to reproduce new filaments 9

9 Sheath containing several trichomes, at least in the larger filaments . . . . A. B.
A. Filaments growing in scattered creeping, erect, or floating wick-like bundles . . . . . . *Microcoleus.*
B. Filaments bundled, erect, growing in small rounded tufts, or in felt-like turf of indefinite extent. Trichomes very slender . . . . *Inactis.*
Sheath enclosing only a single trichome . . . . A. B.
A. Filaments simple, or only exceptionally exhibiting the beginning of ramification where the trichome issues from the side of the sheath . . . . *Lyngbya.*
β Filaments agglutinated in wick-like bundles . . . *Symploca.*
B. Filaments branched. Ramifications produced by the branching of the trichome outside the sheath, very irregular, and often geminate, as in *Scytonema* . . . . . . *Plectonema.*

10 SCYTONEMEÆ Trichomes of which the cells only multiply in the direction of the length of the filament 11
Trichomes of which the cells multiply as well in the direction of the breadth of the filament, at least where the branches, which are always produced by lateral multiplication, originate . . . . . . A. B.
A. Cells of the trichome often geminate or ternate in consequence of their lateral multiplication, or even forming transverse several celled bands. Sheath large. Cells surrounded with a thick membrane very prominent in the old filaments. Hormogones originating in lateral branchlets formed of a single row of cells . . . . *Stigonema.*
β Filaments of the hormogones much slenderer than the principal filament, and originating in unilateral tufts . . . . *Fischera.*

B. Trichomes formed mostly of a single row of cells. Sheath slender. Aquatic plants looking like *Tolypothrix* . . . . . . *Haplosiphon.*

11 Sheaths enclosing several trichomes . . . *Cystocoleus.*
Sheaths enclosing only a single trichome. Ramifications produced by the deviation of the trichome, which emerges from the side of the sheath . . . . A. B.

A. Ramifications usually geminate, produced by a fold of the trichome which ruptures outside of the sheath, and gives birth to two filaments given off at a right angle. Heterocysts scattered here and there in the trichome without any evident relation to the ramifications . . . . *Scytonema.*

β Sheath very broad, forming a transparent layer around the trichome . . . . *Petalonema.*

γ Filaments agglutinated in erect wick-like bundles . *Symphyosiphon.*

B. Ramifications rarely geminate, oftentimes solitary, and originating at a point where the continuity of the trichome is interrupted by heterocysts. One or several heterocysts placed directly above each branchlet . . . . . . *Tolypothrix.*

12 CALOTRICHEÆ Filaments agglutinated by a more or less firm mucilage. Frond usually with a well defined outline 13
Filaments free, growing in small tufts, or forming a turf of considerable extent . . . . *Calothrix.*

13 Heterocysts scattered. Ramifications very irregular, arising from a fold in the trichome, in the form of a V, where originate two geminate filaments, distinct at the base, but at a certain height transformed, for the greater part, into a single filament, composed of a single row of cells. Frond hollow, but hard, folded and looking like a little *Rivularia* . . . . *Hormactis.*
Heterocysts basal (placed at the base of the principal filaments and branchlets). Ramifications produced by the transverse division of the trichomes, the upper part of which detaches itself and becomes a lateral branchlet, while the lower part extending itself by the side of its old tip makes a new extremity similar to the first 14

14 { Spores originating in the lower part of the trichome . . . . *Glœotricha.*
Trichomes never producing any spores . . . . . A.

A. Frond having a tendency to an hemispherical or bladdery form. Filaments exhibiting a disposition to radiate from the base of the frond . . . . *Rivularia.*

β Frond flat. Filaments erect, parallel . . . . *Isactis.*

Sub-tribe I. Psiloneme.æ. *Filaments not attenuated into a hair-like extremity.*

Family I. NOSTOCEÆ.

Trichomes furnished with heterocysts, involved in a very copious gelatin, more or less firm or diffluent, which is collected into a variously expanded, or very often indefinite thallus, or rarely with the mucilage quickly dissolved, subsolitary.—*Borzi Alg. Fico. p.* 279.

Genus 94. **NOSTOC.** *Vauch.* (1803.)

Thallus gelatinous or membranaceous, girt by a more or less firm periderm, definite, globose, or variously expanded. Trichomes flexuously curved, irregularly interlaced, now and then vaginate, joints globose or elliptical, distinct, or more or less closely connected. Heterocysts terminal or intercalated, larger or equal to the other cells. Spores equal to the heterocysts, or a little larger, green, becoming bluish, olivaceous, or yellowish brown.

The Nostocs consist of a more or less firm jelly, in which beaded filaments are imbedded, consisting of chains of small, somewhat globose simple cells. These filaments or *trichomes* are usually surrounded by a sheath, which is often so delicate as scarcely to be visible, or it is almost obsolete. The frond or thallus may be globose, discoid, lobed, or irregular, with a more or less distinct outer layer forming a kind of epidermis.

At irregular distances in the trichomes are larger cells, or *heterocysts*, formerly regarded as spermatia, which differ in colour from the other cells of the trichome. Individual cells become heterocysts uninfluenced by any definite law at present demonstrated.

Increase in the filaments is caused by division of the cells in the longitudinal direction, whereby the trichome is constantly being lengthened, and new cells added, which lie in the mucilage.

Thuret has explained the process by which new plants originate from fragments of the trichome which he terms *hormogones*. The mucilage of old plants being softened, portions of the threads which lie between the heterocysts are detached and escape from the mucilage, whilst the heterocysts remain behind. These escaped fragments become endowed with motion, similar to that observed in *Oscillaria*. The cells of the hormogone increase by division at right angles to the filament, and ultimately separate longitudinally, becoming the centres of new plants.

Besides the reproduction by hormogones, certain special cells of the trichome enlarge and become converted into spores, which germinate and produce new plants, but no evidence of sexual reproduction has yet been adduced.

Messrs Bornet and Thuret have subdivided the genus *Nostoc* into eight groups, of which two are not represented in Britain. The following is their synopsis, with the British species priuted in small capitals.

I. INTRICATA. Aquatic species. Fronds soft, gelatinous without determinate form, often floating.

A. Trichomes forming irregular masses, deprived of the general mucilage.
Circumvolutions of trichome compact and indistinct . . . . 1. *hederulæ*.
Circumvolutions of trichome distinct . . 2. *tenuissimum*.

B. Trichomes involved in mucilage more or less abundant.
α Trichomes flexuous, aggregated; joints short and close together; sheaths uncoloured, very refractive . . . . 3. LINCKIA.
β Trichomes loosely interwoven, joints of equal diameter, rather distant.
1. Spores subglobose. . . . . 4. PISCINALE.
2. Spores oval.
* Mucilage soft; sheath none, indistinct, or uncoloured . 5. CARNEUM.
** Mucilage firm; sheaths and mucilage tinged with yellow at the periphery . . . . . 6. *rivulare*.

II. GELATINOSA. Fronds soft and gelatinous; adherent; joints of trichomes cylindrically elongated in the young filaments. Spores oblong, large.

A. Growing in watery or inundated places; fronds thick, deformed.
α Trichomes heterogenous, composed of two sorts of joints, one cylindrical, the other cask-shaped or compressed spherical . . . . 7. SPONGIÆFORME.
β Trichomes homogenous . . . . 8. *gelatinosum*.

B. Plant terrestrial. Frond plane, applied to the ground by the inferior surface . . . 9. ELLIPSOSPORUM.

III. HUMIFUSA. Terrestrial species. Fronds at first globose, then confluent, and formiug gelatinous cushions adhering to the substratum by their lower face. Spores smooth.

A. Fronds in orbicular discs, or indefinite and continuous.

a Spores measuring ·004 × ·008 mm. or more.
1. Sheaths confluent, trichomes scattered, irregularly interlaced.
* Spores rounded oval . . 10. *collinum.*
** Spores oval . . . . . 11. MUSCORUM.
2. Sheaths well defined, and separable by pressure, trichomes folded vertically and parallel . . . 12. *Passerinianum.*

β. Spores measuring ·004 × ·006 mm. or more.
* Mucilage tolerably firm; trichomes olive. Spores oval . 13. HUMIFUSUM.
** Mucilage soft, easily diffluent, trichomes æruginous green. Spores subglobose . . . 14. *calcicola.*

B. Fronds deformed, hollow; joints spherical compressed . . . . 15. *foliaceum.*

IV. COMMUNIA. Terrestrial species (sometimes inundated). Fronds at first globose, then becoming tongue-shaped, plane, or irregular, not adherent.
Adult frond suborbicular, folded, undulate, entire or lobed, often perforated; joints spherical-compressed, uniform. . . 16. COMMUNE.

V. SPHÆRICA. Fronds globose or subglobose (often becoming irregular when they grow large), limited by a firm and resisting peridermic coating.
A. Terrestrial species, or sometimes inundated.
a Trichomes not fusiformly swollen between the heterocysts.
1. Fronds attaining 1 m. and more. Trichomes torulose.
* Frond firm, trichomes compact, joints cask-shaped, or compressed sphærical close together, uniform; spores oval, smooth . . . . . 17. SPHÆRICUM.
** Fronds soft, trichomes much spaced out, of unequal size, joints nearly sphærical, sheaths often coloured, contrasting with the generally uncoloured mucilage; spores oval, smooth 18. RUPESTRE.
2 Fronds very small, punctiform, not attaining 1 mm.
Trichomes large; joints cylindrical, a little constricted at the point of junction; spores globose, smooth . . . . . 19. MACROSPORUM.

β Trichomes fusiformly swollen between the heterocysts; joints dissimilar, the one kind straight and elongated, the other larger and sphærical; spores sphærical, rough . . . . . . 20. *sphæroides.*

B. Aquatic species (colour blue, or approaching to blue).
a Trichomes dissimilar, unequal; joints of two forms, the one (young) elongated, the other large, sphærical, often filled with opaque granules . . . 21. CŒRULEUM.

β Trichomes homogenous, regular.
1. Frond very small; trichomes very compact . . . . . 22. *minutissimum.*
2. Frond attaining 2-10 mm.
* Joints sphærical, compressed . 23. *gregarium.*
** Joints discoid, very compact . 24. *edule.*
3. Fronds attaining the size of a nut 25. PRUNIFORME.

VI. VERRUCOSA. Aquatic species. Fronds rounded or discoid, at first full, then hollow, limited at the circumference by a firm and tough periderm. Trichomes thin, very regular, spaced out and a little flexuous at the centre, more compact, and very distorted at the periphery.
a. Fronds subglobose or warted. Mucilage tolerably soft. Trichomes medium compact, and often deprived of sheaths at the periphery . . . . 26. VERRUCOSUM.
b. Fronds at first discoid or tongue-shaped, a little ovoid, hard; trichomes radiating regularly from the centre to the circumference and there forming a very dense layer . . . . 27. *parmelioides.*

VII. ZETTERSTEDTIANA. Aquatic species. Fronds sphærical, hard, tuberculose, divided into radiating separable lobes . . . . 28. *Zetterstedtii.*

VIII. FLAGELLIFORMIA. Terrestrial species. Fronds forming thongs, linear straight, and very long.
Frond linear or setaceous, subdichotomous trichomes longitudinally parallel . . 29. *flagelliforme.*

I. INTRICATA. *Species aquatic, fronds soft, gelatinous without determinate form, often floating.*

Nostoc Linckia. *(Roth.) Born & Thur. Notes Alg. p.* 86, *t.* 28, *f.* 1-12.

Fronds lobed, multipartite, free swimming, as large as a walnut, lobes elongated and anastomosing, æruginous green, at length becoming brownish.

Trichomes flexuous, aggregated, joints short and close, sphærical, or sphærical compressed, sheaths uncoloured, very refractive. Heterocysts slightly oblong. Spores subglobose or oval.

SIZE. Joints ·0035 mm., heterocysts ·005-·006 mm. diam., spores (in form *intricatum*) subglobose ·0065 × ·009 mm.

Rivularia Linkia, Roth. Neue Beitr. p. 263.

Nostoc confusum, Ag. Syst. Alg. p. 22.

Monormia intricata, Berk. Glean. t. 18. Hass. Alg. 286, t. 75, f. 11. Ralfs. Ann. Nat. Hist. 1850, p. 326, t. 8, f. 1.

Anabaena intricata, Kutz. Phyc. Germ. 171. Rabh. Alg. Eur. ii., 183.

Anabaena flos-aquæ, Rabh. Alg. Sachs. No. 27.

Nostoc piscinale, Wittr. & Nord. Alg. Exs. No. 195.

Nostoc intricatum, Meneg. Nost. Ital. p. 122. Borzi Alghe Fico. p. 283.

In ditches (slightly brackish).

"Forming small roundish gelatinous masses, floating amongst different species of *Lemna* in fresh water, but probably within the influence of the tide, and also amongst *Enteromorpha intestinalis*, and even within the frond in brackish water. The plant is at first of an olive yellow gradually assuming a greener tint, and when dried of a deep verdigris. Very gelatinous, delicately branched, the branches very flaccid. Under a high magnifier the whole plant is evidently composed of gelatine, in the centre of which runs a single moniliform filament, following the ramifications, and in its progress curling to and fro repeatedly across the thread, the joints being nearly globular. The specimens from the interior of *Enteromorpha* are paler, and have longer joints amongst the globular ones."—*Berkeley.*

Plate LXXXIX. fig. 1. *Nostoc Linkia* (intricata) nat. size, after Berkeley.

Fig. 2. *Nostoc* completely developed, composed of the interlacings of a single trichome × 350.

Fig. 3. Portion of trichome, spores arrived at complete maturity × 650.

Fig. 4. *a*, spore commencing to germinate; *b*, *c*, *d*, *e*, spores in germination more or less advanced × 650.

Fig. 5. Germinating filament changed into a hormogone × 650.

Fig. 6. Free hormogone × 650.

Fig. 7. Motile trichomes segmenting in fragments, of which each constitutes a hormogone.

Fig. 8. Immovable hormogone commencing to develope × 640.

Fig. 9. Development of hormogones × 650.

Fig. 10. Group of spores germinating × 350.

Fig. 11. Chaplets of spores obtained by cultivation in germination × 650. Figs 2 to 11. After Bornet.

Nostoc piscinale. *Kutz. Tab. Phyc.* II., *t.* 11, *f.* 3.

Fronds attached or free swimming, bullate and tuberculate, verdigris green, rarely rufescent, becoming olivaceous by age.

Trichomes loosely interwoven, joints equal in diameter, rather distant. Spores subglobose.

SIZE.—Joints ·0037-·004 mm., heterocysts ·006 mm., spores ·007 × ·008 mm.

Born. & Thuret Notes Alg. ii., 90.

Nostoc lacustre, Kutz. Tab. Phyc. ii., t. 11, f. 2. Rabh. Alg. Eur. ii., 179. Borzi Alghe Fico. p. 281.

Nostoc agglutinans, Kutz. Tab. Phyc. ii., t. 10, f. 1. Rabh. Alg. Eur. ii., 178.

In ditches.

Plate LXXXIX. fig. 12. Trichomes of *N. piscinale* × 400; fig. 13, portion of trichome with heterocyst × 600; fig. 14, spores in course of development, with mature spores × 600; fig. 15, spores in the early stages of germination × 600.

Nostoc carneum. *Ag. Syst. Alg. p.* 22.

Frond indefinitely expanded, bullate and undulate, flesh coloured, rufescent or purplish.

Trichomes loosely interwoven, joints equal, sheath none, indistinct, or uncoloured, spores oval.

SIZE. Joints ·0037-·004 mm., heterocysts ·006 mm. diam., spores ·006 × ·009 mm.

Rabh. Alg. Eur. ii., p. 180. Born. and Thuret, Notes Alg. p. 91.

Nostoc variegatum, Harv. Man. 183. Kutz. Sp. Alg. 301. Hass. Alg. p. 287, t. 74, f. 3.

Nostoc purpurascens, Kutz. Tab. Phyc. ii., t. 11, f. 4.

Nostoc rufescens, Ag. Syst. 22. Rabh. Alg. Eur. ii., 179.

On rocks.

"First collected in Ireland in 1836, growing on the face of a moist bank over which water trickled. When recent it formed a soft gelatinous mass, of a livid colour, bearing the closest resemblance, both in substance and colour, to those gelatinous medusæ which are cast ashore along the coast."—*Moore.*

Plate XC. fig. 1. *Nostoc carneum*, natural size; fig. 2, trichomes × 400; fig. 3, development of spores × 600.

II. GELATINOSA. *Fronds soft and gelatinous, adherent, joints of trichome cylindrically elongated in the young filaments. Spores oblong, large.*

Nostoc spongiæforme. *Ag. Syst. Alg. p.* 22.

Frond at first subglobose, then indefinitely expanded, becoming rather firm, pale æruginous or olive green, surface tuberculated.

Trichomes heterogenous, composed of two sorts of joints, one cylindrical the other cask-shaped, or compressed sphærical. Heterocysts globose. Spores smooth, oblong.

SIZE. Joints ·004 mm., heterocysts ·007-·008 mm., spores ·006-·007 × ·01-·012 mm.

Born. & Thuret Notes Alg. p. 92. Rabh. Alg. Eur. ii. 178. Kutz. Tab. Phyc. ii., t. 9, f. 4.

Nostoc inundatum, Kutz. Spec. Alg. 299. Rabh. Alg. Eur. ii., 171.

Hormosiphon inundatum, Kutz. Tab. Phyc. ii., t. 27, f. 2.

Hormosiphon stagnalis, Kutz. Tab. Phyc. ii., t. 27, f. 3.

Hormosiphon natans, Kutz. Tab. Phyc. ii., t. 27, f. 4.

In wet or inundated places.

Plate XC. fig. 4. *Nostoc spongiæforme*, natural size; fig. 5, young trichome; fig. 6, mature trichome × 400; fig. 7, portion of mature trichome × 600.

Nostoc ellipsosporum. *(Desm.) Rabh. Alg. Eur.* II., 169.

Plant terrestrial. Frond plane, applied to the ground by the lower surface, gelatinous, rufous brown.

Trichomes densely interwoven, pale æruginous green, joints cylindrically elongated, loosely connected, sheaths broad, homogenous. Heterocysts elongated, elliptical, spores oblong, smooth.

SIZE. Joints ·004 mm., heterocysts ·006-·007 mm., spores ·006 × ·006-·008 × ·019 mm.

Born. & Thuret Notes Alg. ii., 94, t. xxvii., fig. 7-11.

Hormosiphon ellipsosporum, Desm. Pl. Crypt. No. 133.

On the ground amongst moss.

Plate XC. fig. 8. Trichome of *Nostoc ellipsosporum* producing spores × 400; fig. 9, portion of trichome which at one extremity exhibits the sheath; fig. 10, trichome with the greater part of the joints transformed into spores; fig. 11, young trichome from germinating spore. Figs. 9, 10, 11, × 600 diam. after Bornet.

III. HUMIFUSA. *Species terrestrial. Fronds at first globose, then confluent, and forming gelatinous patches adhering by their lower face. Spores smooth.*

Nostoc muscorum. *Ag. Disp. Alg. p.* 55.

Frond dark green, foliaceous, tuberculate, opaque.

Trichomes diffused, irregularly interwoven, pale æruginous green. Sheaths confluent. Heterocysts sphærical, usually intercalated. Spores oval.

SIZE. Joints ·0035 mm., heterocysts ·005 mm., spores ·006 × ·01 mm.

Born. & Thuret Notes Alg. p. 96, t. 27. Rabh. Alg. Eur. ii., 173. Eng. Fl. v., 399. Hass. Alg. 292, t. 74, f. 4. Gray Arr. i., 351.

On calcareous rocks, and the mosses that cover them.

Plate XC. fig. 12. *Nostoc muscorum* nat. size; fig. 13, trichome × 400; fig. 14, sterile trichome; fig, 15, fructifying trichome; fig. 17, trichome with spores involved in sheath; figs. 17, 18, spores germinating; figs. 14-18, × 600, after Bornet.

Nostoc humifusum. *Carm. Eng. Fl.* II., 399.

Frond small, at first globose or subglobose, from the size of a peppercorn, olive, then brownish, shining opaque when dry.

Trichomes olive, slender, vertically folded, sheaths well defined. Heterocysts globose. Spores oval.

SIZE. Joints ·0022 mm., heterocysts ·003 mm., spores ·004 ×·006 mm.

Harv. Man. p. 184. Born. & Thuret Notes Alg. p. 99.
Nostoc parietinum, Rabh. Alg. Eur. ii., 178.
Anabaena granularis, Kutz. Tab. Phyc. i., t. 94, f. 6.
Nostoc granulare, Rabh. Alg. Eur. ii., 163.
Nostoc tepidariorum, Braun. in Rabh. Alg. No. 2461, 2462.

On mosses and on walls in greenhouses, &c.

Plate XCI. fig. 1. *Nostoc humifusum*, nat. size; fig. 2, trichome × 400; fig. 3, portion of trichome × 600.

IV. Communia. *Species terrestrial. Fronds at first globose, then tongue-shaped, plane or irregular.*

Nostoc commune. *Vauch. Conf. p.* 222, *t.* 16, *f.* 1.

Adult frond sub-orbicular, folded, undulating, entire or lobed, often perforated, olive, yellowish-brown, or becoming brownish. Trichomes flexuous, loosely interwoven, pale blue-green. Joints sphærical, compressed, uniform. Heterocysts globose.

Size. Joints, ·0045-·006 (usually ·005) mm., heterocysts ·007 mm.

Rabh. Alg. Eur. ii., 175. Hass. Alg. t. 74, f. 2. Borzi. Alghe Fico. p. 284. Eng. Bot. i., t. 2556, pl. p. 1625. Eng. Bot. i., t. 461. Relh. Cant. 441. Lightf. Fl. Scot. 898. Purt. Midl. Fl. ii., 612. Abbot. Bedf. 271. With. Arr. iv., 80. Jenner Fl. Tunb. Wells, 190. Harv. Man. 183. Johnst. Fl. Berw. ii., 262. Grev. Fl. Edin. 322. Mack. Hib. 245. Flor. Dev. ii., 49. Eng. Fl. v., 398. Dickie Bot. Guide, 310.
Tremella nostoc, Linn. sp.
Nostoc ciniflonum, Born. & Thuret Notes Alg. ii., 102.
Nostoc foliaceum, Ag. Syst. Alg. p. 19. Hass. Alg. t. 76, f. 2. Rabh. Alg. Eur. ii., 173. Eng. Fl. v., 399. Harv. Man. 183. Mac. Hib. 245. Dickie Bot. Guide, 310.
Nostoc arctum, Kutz. Tab. Phyc. ii., t. 7, f. 1.
Nostoc littorale, Kutz. Tab. Phyc. ii., t. 8, f. 1.
Nostoc prismaticum, Cês. in Rabh. Alg. Eur. ii., 169.
Nostoc rugosum, Kutz. Tab. Phyc. ii., t. 11, f. 1.
Nostoc salsum, Kutz. Tab. Phyc. ii., t. 8, f. 3.

On wet ground.

Plate XCI. fig. 4. *Nostoc commune*, nat. size; fig. 5 trichome × 400; fig. 6, portions of trichome × 600, fig. 7, portion of trichome.

V. Sphærica. *Fronds globose or subglobose (becoming irregular when they grow large), limited by a firm and resisting peridermic coating.*

Nostoc sphæricum. *Vauch. Conf.* 223, *t.* 16, *f.* 2.

Fronds firm, sphærical, about the size of a pea, gregarious, olive or bluish-green, or brownish, with a firm brownish or colourless periderm.

Trichomes compact, densely interwoven at the periphery, joints cask-shaped, or compressed sphærical, close together, uniform. Heterocysts subglobose. Spores oval, with a thick tegument, smooth.

SIZE. Joints ·004-·005 mm., heterocysts ·006 mm., spores ·005 × ·007 mm.

Born. & Thuret Notes Alg. p. 108. Rabh. Alg. Eur. No. 746. Harv. Man. 184. Gray Arr. i., 352. Eng. Fl. v., 400. Hass. Alg. 289, t. 76, f. 5 (?). Dickie Bot. Guide, 310.

Nostoc vesicarium, Menegh. Nost. Ital. p. 108 (not Harvey).

Ulva pisiformis, Huds. Fl. Ang. ii., 572.

In springs and mountain rivulets.

"Fronds from half a line to two lines in diameter, globular, firm, smooth, solid, heaped on each other like a parcel of small shells. Internal filaments rather thinly scattered through the mass."—*Carmichael.*

Plate XCI. fig. 8. *Nostoc sphæricum* nat. size; fig. 9, trichome × 400; fig. 10, portion of trichome × 600; fig. 11, spores × 600.

Nostoc rupestre. *Kutz. Spec. Alg. p.* 296.

Fronds soft, globose, olive, becoming brownish, often forming an irregular crust.

Trichomes much spaced out, of unequal size, joints nearly sphærical, sheaths often coloured, contrasting with the generally uncoloured jelly. Spores oval with a smooth tegument.

SIZE. Joints ·005-·008 mm., heterocysts ·007 mm.

Rabh. Alg. Eur. ii., 163. Thuret Notes Alg. p. 112. Borzi Alghe Fico. p. 283.

Nostoc microscopicum, Carm. Harv. Eng. Fl. ii., 399. Harv. Man. 184. Mack. Hib. 245.

On rocks, overrunning mosses, &c.

This species is mixed up by Hassall with *Nostoc muscorum*, if it be not in reality the whole of that species, for there is some doubt whether *N. muscorum*, as defined by Bornet and Thuret was known to him.

Plate XCI. fig. 12. Involved trichomes of *N. rupestre* × 400; figs. 13, 14, 15, young plants in course of development × 400, after Borzi.

Nostoc macrosporum. *Meneg. Mon. Nost.* 116, *t.* 14, *f.* 2.

Fronds very small, punctiform, æruginous-green, or brownish-olive.

Trichomes large, bluish-green, or brownish, joints cylindrical, a little constricted at their junction. Sheaths broad, brownish or yellowish-brown. Heterocysts globose. Spores globose with a smooth tegument.

SIZE. Joints ·008-·009 mm., heterocysts ·009-·01 mm.

Born & Thuret Notes Alg. p. 112. Rabh. Alg. Eur. ii., 163. Hass. Alg. 293, t. 73, f. 1, 2. Borzi Alghe Fico. p. 283.

Hormosiphon macrosporus, Kutz. Tab. Phyc. ii., t. 13, f. 1.
Diplocolon Heppii, Itzig. Phyc. Stud. t. 11, f. 8-12.
Nostoc pyreniacum, Ripart. Bull. Soc. Bot. Fr. (1868.)
Nostoc ichthyon, Rabh. Alg. Eur. ii., 164.

On rocks among moss.

Plate XCII. figs. 1, 2. Involved trichomes of *N. macrosporum* × 400; fig. 3, development of hormogone, × 400, after Borzi.

Nostoc cæruleum. *Lyngb. Hydr. Dan. t.* 68, *f.* B.

Fronds, small, globose or subglobose (½ to 4 lines), fixed or free swimming, usually gregarious, blue or greenish-blue.

Trichomes dissimilar, unequal, joints of two forms, the one (young) elongated, the other larger, nearly sphærical, sometimes filled with opaque granules.

SIZE. Joints ·004-·007 mm., heterocysts ·008 mm.

Born. & Thuret Notes Alg. p. 114. Rabh. Alg. Eur. ii., 167. Nord. & Wittr. Alg. Exs. No. 98. Grev. Sc. Crypt. Fl. t. 131. Hass. Alg. 293, t. 76, f. 11, t. 75, f. 10, t. 74, f. 1. Eng. Fl. v., 400. Harv. Man. 183. Gray Arr. i., 352.
Nostoc cærulescens, Rabh. Alg. Eur. ii., 168.
Nostoc Itzigsohnii, Rabh. Alg. Eur. ii., 168.

On mosses and submerged plants.

Plate XCII. fig. 4. Plants of *Nostoc cæruleum* natural size; fig. 5. trichomes × 400; fig. 6, portion of trichome × 600.

Nostoc pruniforme. *Ag. Disp. Alg. p.* 45.

Frond from the size of a pea to that of a damson, or larger, olive or dark æruginous-green, when old becoming blackish-brown, with a coriaceous periderm, and watery within.

Trichomes loosely interwoven, joints subglobose, compressed, closely connected. Heterocysts globose, usually terminal.

SIZE. Joints ·004-·005 mm., heterocysts ·006-·007 mm.

Born. & Thuret Notes Alg. p. 116. Rabh. Alg. Eur. ii. Kutz. Tab. Phy. ii., t. 4, f. 4. Witt. & Nord. Alg. Exs. 97, 276. (?) Berk. Glean. t. 19, f. 2. Hass. Alg. 291, t. 76, f. 3, 4. Eng. Fl. v., 399. Harv. Man. 183. Gray Arr. i., 352.
Ulva pruniformis, Huds. Ang. ii., 572. Abbot. Bedf. 274. With. Arr. iv., 120. Hull. Br. Fl. 310.
Nostoc coccymelon, Kutz. Tab. Phyc. ii., t. 4, f. 3.

In freshwater pools, rivulets, &c.

Plate XCII. fig. 7. *Nostoc pruniforme*, natural size; fig. 8, trichome × 400; fig. 9, portion of trichome, with spores in course of formation × 600.

VI. VERRUCOSA. *Species aquatic. Fronds rounded or discoid, filled, then hollow, with a tough periderm.*

Nostoc verrucosum. *Vauch. Conf.* 225, *t.* XVI., *f.* 3.

Fronds subglobose or nodulose, warted, brownish-green, jelly tolerably soft, limited at the circumference by a firm and tough periderm.

Trichomes slender, somewhat compact, spaced out, and a little flexuous at the centre, more compact and distorted at the periphery, where they are often deprived of sheaths. Joints subglobose, closely connected. Heterocysts spherical.

SIZE. Joints ·003-·0035 mm., heterocysts ·006 mm., spores ·005-·007 mm.

Born. & Thuret Notes Alg. p. 117. Thur. Ann. Sci. Nat. 1844, ii., t. 9, f. 1-5. Rabh. Alg. Eur. ii., 176. Borzi Alghe Fico. p. 284. Hass. Alg. 291, t. 76, f. 1. Grev. Fl. Ed. 323. Hook. Fl. Scot. ii., 74. Mack. Hib. 245. Fl. Dev. ii., 49. Gray Arr. i., 351. Kutz. Tab. Phyc. ii., t. 9, f. 11. Eng. Fl. v., 400. Harv. Man. 183. Dickie Bot. Guide, 310.

Nostoc irregulare, Wartm. in Rabh. Alg. Eur. ii., 167.

Nostoc nivale, Kutz. Tab. Phyc. ii., t. 8, f. 4.

Nostoc Peloponnesiacum, Kutz. Tab. Phyc. ii., t. 9, f. 3.

Nostoc sphæricum, Meneg. Nost. Ital. 110. Kutz. Tab. Phyc. ii., t. 3, f. 2.

Tremella verrucosa, Huds. Fl. Ang. Lightf. Fl. Scot. 898, With. Arr. iv., 81.

In streams, attached to stones.

Plate XCII. fig. 10. *Nostoc verrucosum*, natural size; fig. 11, trichomes × 400; figs. 12-13, portions of trichome; fig. 14, hormogones undergoing division; figs. 12 to 14 × 600, after Thuret; fig. 16, spores; fig. 17, spore in germination × 600.

GENUS 95. **ANABAENA.** *Bory.* (1823.)

Trichomes moniliform, without sheaths (or rarely vaginate), composed of sub-globose cells, some of which become changed into globose or elongated spores, usually yellowish brown or golden brown. Heterocysts intercalated in the trichomes. Spores originating in cells not adjoining the heterocysts.—*Born. and Thur. Notes Alg.*

Recent authors have modified this genus in different directions. Borzi does not adopt the same limitations as Thuret, neither does Kirchner or Professors Nordstedt and Wittrock.

Professor Wittrock suggests that the genus *Anabaena* should be divided into four sub-genera, under the following designations :—

SUB-GEN. 1. **Trichormus.** Spores globose, or subglobose, heterocysts intercalated, distant from the spores.

SUB-GEN. 2. **Dolichospermum.** Spores subellipsoid or subcylindrical, heterocysts as in *Trichormus.*

SUB-GEN. 3. **Sphærozyga.** Spores subellipsoid or subcylindrical, heterocysts intercalated, proximate to the spores.

SUB-GEN. 4. **Cylindrospermum.** Spores subellipsoid or cylindrical, heterocysts for the most part terminal and proximate to the spores.

Anabaena flos-aquæ. *Kutz. Tab. Phyc.* I., *t.* 94.

Free swimming, membranaceous, blue-green. Trichomes more or less curved, often circinate, joints sphærical, or from mutual pressure elliptic or quadrate. Heterocysts intercalated, elliptical. Spores globose.

SIZE. Cells ·0045-·006 mm; heterocysts ·012-·014 mm. long; spores ·008-·01 mm.

Rabh. Alg. Eur. ii., 182. Kirch. Alg. Schl. 235.

Nostoc flos aquæ, Lyngb. Hydro. t. 68, f. D.

Trichormus incurvus, Allm. Ann. Nat. Hist. xi., 163.

var. **circinalis.** *Kirch. Alg. Schl.* 235.

Trichomes more circinate, and joints rather larger.

SIZE. Cells ·007-·01 mm. ; spores ·012-·014 mm. diam.

Anabaena circinalis, Rabh. Alg. Eur. ii., 183.

Anabaena spiralis, Thompson Ann. Nat. Hist. (1846) v., p. 81.

Trichormus spiralis, Ralfs Ann Nat. Hist. (1850) p. 328.

In ponds, moor pools, &c.

Plate XCIII. fig. 1. Trichomes × 400 diam.; *b Trichormus spiralis* after Ralfs ; *c* var. *circinalis,* trichomes × 400.

From the description and figure given by Ralfs, under the name of *Trichormus spiralis,* we have no doubt that Thompson's Alga, which himself termed *Anabaena spiralis,* was the variety *circinalis* of this species, although Hassall's figure and interpretation is entirely different. The account which Thompson gives of his "Alga which colours Ballydrain Lake," is as follows :—

"On visiting the lake (July 15) to-day I found that the whole body of water was tinged with a dull faintly glaucous hue. On going out in a boat to ascertain the cause of this appearance, I saw that the water was everywhere filled with extremely minute particles, which might be compared to the motes in a sunbeam. To the unassisted eye they seemed as delicate as the finest human hair, and of a spiral form. On enquiry I learned that the appearance had been observed only for the last four or five years, and for about three months in each year. One of my friends had looked upon its approach with dread, as it interfered so much with his angling, that during the period of its continuance this spot had to be abandoned." Subsequently the plant was observed as late as the 27th September, but on October 7th all had disappeared. In the following year the Alga was seen first on the 3rd of July, and last on the 23rd of September.

"The specimens obtained were invariably of similar breadth, and rarely presented more than four spiral turns, and when of this size were 1-50th of an inch in length. The species at first, when mingling with the water, is of a dark green colour, when in calm weather it ascends to the surface in separate particles it appears pale green; when it does so *en masse* (the earliest symptoms of decay) it is of a pale blue, and in the last stage of decomposition ferruginous. When two of the spiral portions come in contact they have an elastic power, by which they can, though slowly, disentangle themselves, and separate from each other."

Anabaena variabilis. *Kutz. Phyc. Gen.*

Gelatinous, submembranaceous, deep blue-green. Trichomes slightly flexuously curved, almost parallel, verdigris green, joints globose or elliptic, compressed or depressedly subcylindrical, 1-1½ times longer than broad; heterocysts intercalated, paler; spores numerous, seriate, ellipsoid, golden tawny, with a rather thick membrane.

SIZE. Cells ·0035-·004 mm.; heterocysts ·007 mm.; spores ·00801 × ·012 mm.

Sphærozyga Thwaitesii, Harv. Phyc. Britt. t. 113, B.

Sphærozyga variabilis, Kutz. Tab. Phyc. i., t. 96, Rabh. Alg. Eur. ii., 193.

Trichormus rectus, Ralfs Ann. Nat. Hist. (1850) t. 8, f. 6.

Anabaena licheniformis, Hass. Alg. 82, t. 75, f. 4?

Trichormus Thwaitesii, Ralfs Ann. Nat. Hist. (1850) p. 329, t. 8, f. 4.

In ditches.

It forms thin gelatinous dark green patches either on the damp soil covered at springtides, or at the bottom of brackish ditches and pools.

Plate XCIII. fig. 2. Trichomes × 400, with heterocysts and spores.

Anabaena Hassallii. *Nord. and Wittr. Algæ Exs.*

Trichomes equal, curved, often circinate, interwoven in a thin blue-green stratum, joints globose or more or less compressed, delicately granular; heterocysts sphærical, colourless, intercalated without order; spores oblong cylindrical, single or in pairs, distinctly curved, dark blue green, densely granulated, 1½-2½ times as long as broad.

SIZE. Cells ·008 mm.; heterocysts ·009-·01 mm.; spores ·012 × 025 mm.

Sphærozyga Hassallii, Rabh. Alg. Eur. ii., 195.

Anabaena flos-aquæ, Hass. Alg. 282, t. 75, f. 2, Harv. Man. p. 186.

Dolichospermum Thompsoni, Ann. Nat. Hist. (1850), t. 9, f. 3.

Anabaena circinalis, Phillips in Grevillea ix., p. 4, t. 134, figs. *e, f, g*.

In ditches with *Confervæ*, and floating on lakes.

"Floating like powdered verdigris on mountain lochs." This species seems to be variable in the form and size of the spores, and in the number of vegetative cells which occur between the heterocysts and spores. Wittrock has figured varieties in which two, or even sometimes one, cell intervenes between the heterocyst and spore, alluding to the fact that in English specimens they are sometimes in juxtaposition. Although technically the Shropshire specimens would seem to belong to *Sphærozyga*, yet in all other features they agree so well with this species that we have cited them here as abnormal forms of the present species.

Plate XCIII. fig. 3. Portions of trichomes with heterocysts and spores × 400; *b*, after Ralfs; *c*, after Phillips.

Anabaena Ralfsii. (*Kutz.*)

Forming extensive strata of a velvety rich dark green colour, sometimes verging towards verdigris green.

Trichomes moniliform, joints sphærical. Heterocysts elliptical, spores elliptic or cylindrical, one or two in each series not contiguous to the heterocysts.

Size. Cells ·004 mm. diam. Heterocysts ·005-·006 × 008 mm. Spores ·008-·01 × ·022-·03 mm.

Sphærozyga Ralfsii (Thw.) Rabh. Alg. Eur. ii., 193. Kirch. Alg. Schl. 237.

Dolichospermum Ralfsii, Ann. Nat. His. 1850, t. 9, f. 2.

Cylindrospermum Ralfsii, Kutz. Tab. Phyc. t. 98, f. 7.

In bogs and rivulets.

"Distinguished from *A. inæqualis* by its elliptical heterocysts (which are comparatively less broad), by its more orbicular ordinary joints, and by having fewer spores."—*Ralfs.*

Plate XCIV. fig. 1. Trichomes with heterocysts and spores × 400 diam.

Anabaena Smithii. (*Thw.*) *Nord. & Wittr. Alg. Exs. No.* 197.

Trichomes straight, each included in a definite gelatinous sheath; joints subsphærical, compressed, about as long as wide; heterocysts subsphærical somewhat barrel shaped, half as wide again as the joints, puncta very distinct; spores cylindrical, very unequal in length, with the ends rounded and somewhat truncate.

Size. Cells ·004-·006 mm. diam. Heterocysts ·008-·009 × ·009-·013 mm. Spores ·009-·012 × ·02-·04 mm. (*Wittrock.*)

Dolichospermum Smithii, Thwaites Ann. Nat. Hist. 1850, t. 9, f. 4.

In boggy pools with other Algæ.

"Immediately distinguishable from its congeners on account of its possessing a definite gelatinous sheath to each of its filaments, which are of smaller diameter than those of any other species of *Dolichospermum*. The ordinary cells are subspherical, somewhat compressed, and of less diameter than the heterocysts, which are barrel-shaped, and with very distinct puncta. The numerous spores, which are about twice the diameter of the ordinary cells, are elongated and cylindrical, very variable in length and in the number which occur together, and their ends are slightly truncate."—*Ralfs.*

Plate XCIII. fig. 7. Portions of trichomes with heterocysts and spores × 400; fig. *a* from Scandinavian specimens; fig. *b* from British specimens.

Anabaena oscillarioides. *Bory. Dict. Hist. Nat.*

Forming a bluish green stratum.

Trichomes elongated flexuous, joints subquadrate, distinct; heterocysts barrel-shaped or elliptic. Spores oval, catenate, somewhat larger than the vegetative cells.

SIZE. Cells ·004-·005 × ·004-·006 mm. Heterocysts ·006-·008 × ·007-·009 mm. Spores ·007-·008 × ·008-·012 mm. (*Wittrock.*)

Nord. & Wittr. Alg. Ex. No. 196.

Sphærozyga oscillarioides, Kutz. Sp. Alg., p. 291. Borzi. Alg. Fico. 286.

Trichormus oscillarioides, Ralfs in Ann. Nat. Hist. 1850, p. 329, t. 8, f. 5.

In brackish ditches.

"It differs from *A. Thwaitesii* by its more quadrate ordinary cells, and by its smooth and elliptical heterocysts."—*Ralfs.*

Plate XCIII. fig. 6. Portions of trichomes with spores and heterocysts × 400.

Anabaena Thwaitesii. (*Ralfs.*)

Trichomes moniliform, straight or nearly so, joints quadrate. Heterocysts oblong sub-quadrate, hardly exceeding the joints in diameter. Spores numerous, cylindrical with truncate ends, very variable in length.

SIZE. Cells ·006-·007 mm. Heterocysts ·008 × ·01 mm. Spores ·01-·012 × ·025-·03 mm.

Dolichospermum Thwaitesii, Ralfs Ann. Nat. Hist. 1850, 337, t. 9, f. 5.

In freshwater pools, and brackish ditches.

Allied to *A. Smithii*, but its filaments are not included in a definite gelatinous sheath. Its filaments are also stouter, and there is a difference in the form of its cells. The heterocysts are quadrangular, and hardly exceed in diameter the ordinary cells. The cylindrical truncated spores are numerous, many in a chain, and variable in length, about twice the diameter of ordinary cells.

Plate XCIII. fig. 5. Portions of trichomes with heterocysts and spores × 400.

Uncertain Species.

Anabaena inæqualis. (*Ralfs.*) *Braun., in litt.*

Forming extensive strata consisting of thick gelatinous masses of a deep green colour.

Trichomes stout, moniliform, elongated, joints distinct, at first quadrate, finally orbicular, with granular contents. Heterocysts globose, broader than the ordinary joints, occurring at short intervals. Spores 3-4 times longer than broad, with truncate ends, in chains of two to five.

SIZE. Not determined.

Dolichospermum inæquale, Ralfs Ann. Nat. Hist. 1850, 335, t. 9, fig. 1.

Sphærozyga inæqualis, Kutz. Tab. Phyc. i., t. 96. Rabh. Alg. Eur. ii., 194?

In boggy pools.

We have seen no specimens of this, or of Kutzing's *Sphærozyga inæqualis,* and therefore cannot pronounce on their identity. Mr. Ralfs says that "this plant forms extensive strata, composed of thick gelatinous masses of a deep green colour. Filaments elongated, consisting of from 100 to 200 cells, and, being stouter than in most species belonging to this genus, visible to the naked eye. Ordinary cells distinct, quadrate in immature specimens, but at length nearly spherical, appearing punctate on account of the scattered granular matter which they contain. Vesicular cells (Heterocysts) spherical broader than the ordinary joints and occurring at short intervals. Spores 3 to 4 times longer than broad, with truncate ends; in chains of from two to five members." May be known from *A. Ralfsii* by its spherical heterocysts and catenate spores.

Plate XCIII. fig. 4. Trichomes with heterocysts and spores × 400; after Ralfs.

GENUS 96. **APHANIZOMENON.** *Morren.* (1839.)

Thallus membranaceous, free swimming, bright blue, blue green, or becoming olive. Trichomes medium size, a little attenuated towards the apex, agglutinated parallelly and very densely in fascicles, joints cylindrical, very closely connected, pale blue, nearly colourless and delicately granular. Spores elongated, cylindrical, rounded at the ends, pale blue, or somewhat olive, exospore thin, quite smooth. *Borzi Alg. Ficochrom.* p. 279.

Thuret places this genus next to *Anabaena,* but, in the absence of heterocysts, it seems that its proper place would be in *Lyngbyæ,* allied to *Oscillaria.* We have retained it here, in preference to altering the "key to the genera," which is given on page 221.

Aphanizomenon flos-aquæ. *Ralfs Ann. Nat. Hist. t.* 9, *f.* 6.

Floating, forming a pale or dark blue green stratum on the surface of the water. Trichomes very thin, nearly straight, aggregated in membranaceous flakes which readily separate, either distinctly or indistinctly articulated, very pale blue or colourless. Joints cylindrical, about as long as broad, slightly granular. Spores more or less elongated cylindrical, 6-12 times as long as broad, granular.

SIZE. Cells ·003-·004 mm. diam. Spores ·005 × ·03-·04 mm.

Allman, Quart. Journ. Micr. Sci. 1855, p. 21, t. 3.

Byssus flos-aquæ, Linn. Spec. Plant. (1753) No. 1168.

Limnochlide flos-aquæ, Kutz. Tab. Phyc. i., t. 91, f. 2, *a*.

Aphanizomenon incurvum, Morr. Bull. Brux., 1839, Harv. Man. 145, Hass. Alg. 280, t. 76, f. 6.

Sphærozyga flos-aquæ, Rabh. Alg. Eur. ii., 195.

In ditches, ponds, and meres.

One of the species of Algæ which contribute to the phenomena characterized as "breaking of the meres," Professor Allman thinks that he has observed heterocysts (see Micr. Journ. p. 22), but this is not confirmed.

Plate XCIV. fig. 1. *a*, Trichomes in bundles, × 200 ; *b*, Trichomes, with spores × 400.

GENUS 97. SPHÆROZYGA. (*Ag.*) *Ralfs.* (1850.)

Trichomes involved in an amorphous, often very quickly diffluent, mucilage, rarely vaginate, agglutinated in an indefinite gelatinous stratum ; joints sphærical, elliptical or oblong, transversely compressed and often quadrangular. Heterocysts intercalated, binary, or solitary. Spores originating in cells placed on each side of the heterocysts.

Sphærozyga Carmichaeli. *Harv. Phyc. Britt. t.* 113.

Stratum thin, of a dark or bluish green colour when recent, but opaque and glaucous when dry. Trichomes moniliform, with tapering extremities; joints distinct, somewhat quadrate. Heterocysts sphærical. Spores oblong.

SIZE. Cells ·0035-·0045 mm. Heterocysts ·006 mm. diam. Spores ·008-·01 × ·018-·025 mm.

Kutz. Tab. Phyc. i., t. 99, f. 4. Ralfs Ann. Nat. Hist. 1850, t. 8, f. 7. Rabh. Alg. Eur. ii., 191.

Belonia torulosa, Carm. Eng. Fl. v., 379. Harv. Man. 167.

On damp soil in salt marshes flooded at spring tides, in brackish ditches, &c.

"The hest distiuctive mark of this species is the subacute extremities, combiued with the short filament and littoral habitat. There are rarely more than one or two groups of enlarged cells, when only one is present it is situated near the centre of the filament. I believe that the attenuated extremities are constant, at least in the young plant, unless the filament has been broken."—*Ralfs.*

Plate XCIV. fig. 3. Portions of trichomes with heterocysts and spores × 400.

Sphærozyga Broomei. *Thwaites in Harv. Phyc. Britt.*

Stratum bluish or yellowish green. Trichomes moniliform, joints subsphærical. Heterocysts smooth, subquadrate, rather longer than wide. Spores numerous, elliptical, twice as long as wide, not much exceeding in width the joints, commencing to be formed on either side next to the heterocysts.

SIZE. Cells ·004 mm. Heterocysts ·005 × ·006 mm. Spores ·008 × ·016 mm.

Thwaites in Harv. Phyc. Britt. t. 173, fig. A. Ralfs Ann. Nat. Hist. (1850) t. 8, fig. 10.

On dead leaves of *Myriophyllum* in brackish ditch.

"The gelatinous matrix is firmer than in many species of this genus. The numerous spores in each series distinguish it from every other species I am acquainted with."—*Ralfs.*

Plate XCIV. fig. 4. Portions of trichomes, with heterocysts and spores × 400.

Species imperfectly known.

Sphærozyga Berkeleyana. *Thwaites in Harv. Phyc. Britt.*

Young trichomes included, one or several together in a defined mucous sheath. Joints sphærical, compressed. Heterocysts sphæroidal, slightly compressed. Spores usually two on each side of the heterocysts, large, twice the width of the joints, oblong, half as long again as wide, becoming brown when mature.

SIZE. Cells about ·006-·007 mm. Spores about ·012 × ·015 mm.

Thwaites in Harv. Phyc. Britt. t. 173, fig. B. Ralfs Ann. Nat. Hist. 1850, 334, t. 8, fig. 11.

Amongst *Cladophora fracta,* in brackish ditch.

Mr. Ralfs says: "The turgid spores and large compressed heterocysts characterise this species," of which we have no knowledge.

Plate XCVI. fig. 9. Portions of trichomes, with heterocysts and spores × about 400. After Harvey.

Sphærozyga Jacobi. *Ralfs Ann. Nat. Hist.* 1850, 332, *t.* 8, *fig.* 8.

Forming thick bluish green gelatinous masses, from which the filaments issue in long rays.

Trichomes elongated, ends attenuated, joints quadrate, then globose, the terminal one longer than broad, and usually conical. Heterocysts sphærical, larger than the joints. Spores oblong or cylindrical, one or two on each side of the heterocysts.

SIZE. Cells about ·005 mm. Spores ·008 × ·02-·025 mm.

Berkeley in Eng. Bot. ii., t. 2,826, fig. 2.

Cylindrosporium licheniforme, Kutz. Spec. 292?

In streams, pools, &c.

We have seen no specimen of this, and cannot say whether it is Agardh's species or not. Although ignored by Continental botanists, it would seem from the figure, which we have reproduced, to be a distinct species.

Plate XCIV. fig. 5. Portions of trichomes with heterocysts and spores × about 400, after Ralfs.

Sphærozyga Mooreana. *Ralfs Ann. Nat. Hist.* 1850, *t.* 8, *f.* 12.

Trichomes scattered, joints minute, somewhat orbicular. Heterocysts minute, barrel-shaped, much narrower than the spores. Spores very turgid, often nearly orbicular or broadly elliptical, much larger than the joints or heterocysts.

SIZE. Cells about ·0035-·004 mm. Spores about ·008 × ·012-·015 mm.

Mixed with other algæ.

"I have only seen imperfect and dried filaments of this species intermixed with *Nostoc variegatum*, Moore; in a recent state therefore the form of the joints may not agree with the above description, still the large turgid spores must distinguish it from every species but *S. Berkeleyana*, and from that it differs in its heterocysts, which are comparatively much smaller and also longer than broad."—*Ralfs.*

Plate XCIV. fig. 6. Portion of trichome with heterocyst and spores × about 400 after Ralfs.

Sphærozyga leptosperma. *Ralfs. Ann. Nat. Hist.* 1850, 334, *t.* 8, *f.* 13.

Forming large shapeless gelatinous masses, varying from deep green to pale yellowish green.

Trichomes elongated, not constricted at the dissepiments, joints longer than broad, separated only by transverse dissepiments, which are not contracted, and indeed are often so obscure that they can hardly be detected. Heterocysts at first barrel-shaped, finally elliptic, broad at the spores. Spores cylindrical, 4-6 times longer than broad truncate, slightly broader than the ordinary joints.

Size. Cells ·004 mm. diam. Spores about ·007 × ·02-·03 mm.

Cylindrospermum leptospermum, Kutz. Tab. Phyc. i., t. 99. f. 11. Bot. Leit. p. 198.

In ditches and pools.

"The confluent vegetative cells, with their obscure dissepiments, distinguish this from every other British species."—*Ralfs.*

Of this also we have no personal knowledge.

Plate XCIV. fig. 8. Portion of trichome with heterocyst and spores × about 400. After Ralfs.

Sphærozyga elastica. *Ralfs Ann. Nat. Hist.* 1850, 333, *t.* 8, *fig.* 9.

Stratum deep bluish green, tender.

Trichomes elongated, constricted at the dissepiments, joints about equal in length and breadth, but when dividing they lengthen, and though quadrate in the recent plant they acquire slightly rounded angles when dry. Heterocysts at first barrel-shaped, then elliptic. Spores cylindrical, 4-8 times longer than broad, ends at first truncate, but rounded after separation.

Size. Cells about ·005 mm. Spores ·008 × ·025 mm.

Sphærozyga elastica, Agardh Icon. Alg. ?

Cylindrospermum elongatum, Kutz. Tab. Phyc. i., t. 99, f. 111.

In bogs.

"The moniliform filaments and shorter joints distinguish this species from *S. leptosperma*, and its elliptic heterocysts from *S. Jacobi* and *S. Carmichaeli.*"—Ralfs.

Plate XCIV. fig. 7. Portions of trichomes with heterocysts and spores × about 400, after Ralfs.

Genus 98. CYLINDROSPERMUM. (*Kutz.*) *Ralfs* 1850.

Heterocysts terminal, single. Other characters the same as in *Sphærozyga*. Spores originating in cells placed just below the heterocysts.

Cylindrospermum macrospermum. *Kutz. Tab. Phyc.* i., *t.* 98, *f.* 4.

Trichomes curved or nearly straight, pale blue green, more or less interwoven ; joints globose or elliptic, often mixed with others somewhat cylindrical, either homogenous or granular. Heterocysts terminal, elliptical. Spores elliptic oblong, or oblong cylindrical, green or yellowish brown, darker brown when mature, granular, twice as long as broad.

Size. Cells ·003-·004 mm., heterocysts rather longer. Spores ·014 × ·025-·03 mm.

Kirch. Alg. Schl. 237. Rabh. Alg. Eur. ii., 186.

Anabaina impalpebralis, Hass. Alg. 283, t. 75, f. 3.

In ditches and ponds.

Plate XCV. fig. 1. Trichomes with heterocysts and spores × 400.

Cylindrospermum catenatum. *Ralfs Ann. Nat. Hist. t.* 8, *f.* 14.

Stratum bluish green. Trichomes very fine elongated straight, or slightly flexuous, generally parallel, moniliform. Joints sphærical minute. Heterocysts oval. Spores 2-8 in each series, at first sphærical, then more or less oval, but little broader than the heterocysts.

Size. Cells about ·003 mm., heterocysts a little longer, spores about ·006 × ·008 mm.

Rabh. Alg. Exs. No. 1358.

In fresh water.

Clearly distinguished from the preceding species by its numerous spores.

Plate XCV. fig. 2. Trichomes with heterocysts and spores × 400.

Genus 99. NODULARIA. *Mertens.* (1822.)

Trichomes distinctly vaginate, with very closely compressed disc-shaped joints, collected in a gelatinous or membranaceous irregularly diffused stratum. Heterocysts intercalated at regular intervals, vegetative joints nearly equal, transversely compressed. Spores fuscous, or golden yellow, becoming tawny, globose, slightly compressed.

Nodularia litorea. (*Thw.*) *Thur. Ann. Sci. Nat.* 1875, 378.

Scarcely gelatinous, forming a deep green fleecy covering to floating plants on which it occurs. Trichomes of considerable diameter, nearly straight. Joints of a beautiful blue green colour, very short and compressed, giving the filaments the appearance of an *Oscillaria*. Heterocysts pale reddish. Spores elliptical, at length acquiring a deep brown colour.

Size. Trichome, without sheath, ·012 mm.

Born. and Thur. Notes Algol. ii., 121, t. 29, f. 1-9.

Spermosira litorea, Kutz. Phy. Gen. 213. Rabh. Alg. Eur. ii., 186. Harv. Phy. Britt. t. 113, f. *c*.

In muddy, brackish ditches.

Plate XCV. fig. 3. *a*, portion of trichome, with heterocysts × 400; *b*, portion × 600; *c*, fertile portion, with spores × 600; *d*, spores × 600; *e*, spore germinating, after Thuret.

Nodularia Harveyana. *Thur. in Ann. Sci. Nat.* 1875, 378.

Trichomes much curved, composed of cells nearly as long as broad. Heterocysts subquadrate, rather longer than wide, and of the same width as the joints. Spores sphærical, almost twice the diameter of the joints.

SIZE. Trichomes ·0065 mm. diam.

Born. and Thur. Notes Alg. ii., t. 29, f. 14-16.

Spermosira Harveyana, Thw. in Harv. Phyc. Britt. t. 173, f. *c*. Rabh. Alg. Eur. ii., 295.

In brackish ditches.

Plate XCV. fig. 4. *a*, portion of trichome with heterocysts × 400; *b*, the same × 600; *c*, portion of trichome with spores × 600; *d*, germinating spores, after Thuret.

FAMILY II. LYNGBYÆ.

Filaments without heterocysts, and destitute of a terminal hyaline hair, single, and scattered, or numbers associated in bundles and enclosed in a common sheath, often radiating. Joints shortly cylindrical, disc-shaped in section.

GENUS 100. **SPIRULINA.** *Link.* (1834.)

Trichomes articulated, spirally twisted, motile, nestling in a more or less liquid colourless matrical mucilage. Propagation unknown.

Consult Cohn in Nova Acta Car. Leop. vol. xxiii. Braun in Botanische Zeitung 1852, p. 395. Reinicke Beitr. zur neuern Mikrosk ii., pp. 1-56.

Spirulina Jenneri. *Kutz. Tab. Phyc.* I., *t.* 37, *f.* 11.

Trichomes more or less elongated, distinctly articulated, spirals lax, distant, joints equal in length to their diameter, or a little shorter. Cell-contents pale or bright blue green.

SIZE. Trichomes ·007-·008 mm. diam.

Rabh. Alg. Eur. i., 90. Kirch. Alg. Schl. 250.

Spirillum Jenneri, Hass. Alg. 277, t. 75, f. 5.

Arthrospira Jenneri, Hedwigia i., p. 32, t. 5.

In stagnant water.

Plate XCVI. fig. 1. Portions of trichomes × 400.

Spirulina oscillarioides. *Turp.*

Solitary, or forming little green tufts, sometimes almost radiating. Trichomes more or less elongated, nearly erect, pale blue green, twisted in lax or dense spirals, endowed with active motion.

SIZE.—Trichomes ·0015-·002 mm. diam.

Kutz. Tab. Phyc. i., t. 37, f. 8. Rabh. Alg. Eur. ii., 91. Kirch. Alg. Schl. p. 250. Cohn Nova Acta xxiv., t. 15, f. 15.

var. b. **minutissima.** *Rabh. Alg. Eur.* II., 91.

Trichomes abbreviated, more loosely spiral.

Spirillum minutissimum, Hass. Alg. 278, t. 75, f. 8.

Spirulina brevis, Kutz. Tab. Phyc. i., t. 37, f. 9.

In fresh, brackish, or thermal waters.

Plate XCVI. fig. 3. Portions of trichomes × 400. Fragment further magnified.

Spirulina tenuissima. *Kutz. Spec. Alg.* 236.

Forming a membranaceous, lubricous, dark blue green floating stratum, trichomes very thin, flexuous, very densely spiral, endowed with active motion; joints very indistinct.

SIZE.—Trichomes very thin. Spirals ·005 mm. diam.

Rabh. Alg. Eur. ii., 92. Harv. Phyc. Britt. t. 105, f. *c.*

In brackish ditches.

Floating in large blue green masses on the surface of brackish ditches. The threads are too delicate for measurement, and appear only as lines under a magnifying power of 400 diameters.

Plate XCVI. fig. 2. Portions of trichomes × 400.

GENUS 101. **OSCILLARIA.** *Bosc.* (1800.)

Trichomes simple, usually distinctly articulate, rigid, straight, or a little curved, rarely circinate or spirally convolute, for the most part brightly coloured (blue-green, steel-blue, violet, æruginous, &c.), motile, nestling in a matrical mucilage; joints disc-shaped in the front view, without a sheath distinct from the trichome.

Consult Dr. d'Alquen in Quart. Journ. Micr. Sci. iv. (1856), p. 245.

The species are at present distinguished by very artificial characters, which are by no means permanent, in which respect the genus is not in a much better condition than it was forty years ago.

Oscillaria tenerrima. *Kutz. Tab. Phyc.* I., *t.* 38, *f.* 8.

Solitary and scattered, or associated in fascicles. Trichomes straight, indistinctly articulate, joints equal in length to their diameter, or a little longer or shorter, ends somewhat acute, slightly inclined ; cell-contents pale blue green, or olive, homogenous or very finely granular.

SIZE. Threads ·0018-·0025 mm. diam.

Rabh. Alg. Eur. ii., 96.

In ditches, amongst decaying vegetable matter.

Plate XCVI. fig. 4. Trichomes × 400.

Oscillaria leptotricha. *Kutz. Tab. Phyc.* I., *t.* 38, *f.* 9.

Solitary, scattered, or collected in a very thin blue green stratum, trichomes very slender, slightly curved, indistinctly articulate, joints twice as long as broad, or after division equal, very minutely punctate at the periphery, attenuated at the ends, which are straight, curved, or deflexed, cell-contents pale blue, green, homogenous or finely granular.

SIZE. Threads ·003 mm. diam.

Rabh. Alg. Eur. ii., 97.

In fresh or brackish ditches.

Plate XCVI. fig. 5. Trichomes × 400.

var. **splendida.** (*Grev. Fl. Edin.* 304.)

SIZE. Trichomes not exceeding ·002 mm. diam.

Oscillatoria splendida, Eng. Fl. v., 375. Harv. Man. 164. Hass. Alg. 251, t. 72, f. 8.

In tubs of water in a stove. Edinburgh Botanic Gardens.

Plate XCVI. fig. 6. Trichomes × 400.

Oscillaria spiralis. *Carm. Harv. Phyc. Britt. t.* 105B.

Effused in a firm coriaceous glossy black stratum. Trichomes radiating, slender, long, flexuous, regularly twisted in spirals.

SIZE. Threads ·0035-·004 mm. diam.

Spirillum rupestre, Hass. Alg. 277, t. 75, f. 6.

Spirulina rupestre, Rabh. Alg. Eur. ii., 93.

On rocks by the seaside.

"It spreads over the dry naked earth. Stratum several feet in extent, firm, coriaceous, of a glossy black colour, void of lubricity. Filaments about half a line in length, twisted like a corkscrew, radiating in all directions."—*Carmichael.*

Plate XCVIII. fig. 7. Trichomes × 400, from the original specimens.

Oscillaria rubiginosa. *Carmichael Alg. App. ined.*

Stratum gelatinous, dark purple; trichomes very thin, straight, indistinctly articulated, laid on a thin, compact, greenish substratum.

SIZE. Threads ·004-·0045 mm. diam.

Oscillaria violacea, Rabh. Alg. Eur. ii., 113. Eng. Fl. v. 377.

Oscillatoria violacea, Hass. Alg. 254, t. 72, f. 10. Harv. Man. 166. Johnst. Fl. Berw. ii., 264.

Conferva mucosa confragosa rivulis innascens, Dillen (?)

Rapid streams, and on stones at the bottom of rivers.

When dry the filaments of this species assume a blackish green cast, with an evident gloss. Striæ when dried almost invisible, at a distance of about two diameters from each other.—*Hassall.*

As another species is called *Oscillaria violacea* (Wallr), which has priority, the name proposed by Carmichael must be adopted.

Plate XCVIII. fig. 6. Portions of trichomes × 400, from the original specimens.

Oscillaria subfusca. *Vauch. Conf.* 193, *t.* 15, *f.* 5.

Forming a very thin, greenish brown, then blackish stratum, shortly radiating. Trichomes equal, straight, curved at the apex (curvature of 4 to 5 joints), joints about equal in length to their breadth (after division shorter), dissepiments very distinctly granulate, extreme apical point fimbriate, or bearded. Cell-contents pale greenish steel-blue, granular.

SIZE. Threads ·0045-·006 mm. diam.

Rabh. Alg. Eur. i., 100. Kirch. Alg. Schl. p. 246. Mack. Hib. p. 240. Eng. Fl. v., 377. Harv. Man. 166.

Oscillatoria subfusca, Hass. Alg. 253, t. 72, f. 9.

Attached to wood, rocks, stones, &c., in streams.

"Stratum extensive, soft, slimy, void of tenacity, wrinkled, of a dusky grey colour, when dry greyish-brown, streaked with green towards the edges; filaments very slender, striæ invisible."—*Harvey.*

Plate XCVI. fig. 7. Portions of trichomes × 400.

Oscillaria ærugescens. *Drumm. Ann. Nat. Hist.* (1838) I, *p.* 1.

Stratum of a fine deep green, highly gelatinous, when dried æruginous blue, and glossy; trichomes very slender, opaque green, conglomerated in large masses, rarely floating, or broken into fragments and suspended like cloudy flocculi in the water, joints about half their diameter long.

SIZE. Trichomes ·005 mm. diam.

Oscillatoria ærugescens, Hass. Alg. 249, t. 72, f. 2. Harv. Man. 163.

In lakes and pools.

This is the species which Dr. Drummond described as the "colouring substance of Glasslough Lake, Ireland." He commences by stating that "Glas-lough" signifies "green lake," an appellation given to it from time immemorial on account of the hue of its waters, which exhibit a green tinge, equal to, or exceeding in intensity, that of the sea, though it is not at all times equally striking. "From the accounts I received, the green colour is evident in the lough throughout the year, and if I may judge from my own observations, every drop of it is impregnated with the oscillatory filaments." "When a little of the water is lifted in the hand it seems perfectly transparent, and it appears equally clear at the edges of the lake, but at a depth of two feet the bottom is indistinguishable, and the water presents a sort of feculent opacity, accompanied by a dull, dirty, greenish hue. On lifting some of this in a glass it seems at first sight quite transparent, but on holding it up to the light innumerable minute flocculi are seen floating through every part of it, and producing a mottled cloudiness throughout the whole." "At first I could only find the plant diffused through the water, but at length I discovered a wet ditch extending from the lake into an adjoining field, and there it appeared swimming on the surface in large masses several inches in thickness, and above a foot and a half in length. These seemed evidently to be produced by an agglomeration of the filaments floated in from the lake, matted together at the surface, and increased in growth. The surface of these masses, where dried by the contact of the air, was of a bright bluish verdigris hue, while the parts immersed in the water were of a dull opaque green.

"On examining specimens in the microscope, I sometimes observed their motions to be very vivid, and in other instances little or no motion could be perceived. They are extremely minute, their transverse striæ very numerous, and at distances of about half a diameter from each other. The filaments in the conglomerated masses appeared to me to be many inches long, and running parallel together; the broken fragments dispersed through the lake cross each other in all directions."

Plate XCVIII. fig. 5. Trichomes from specimen collected by Drummond × 400 diam.

Oscillaria tenuis. *Ag. Syst. Alg. p.* 60.

Forming a bright green, or dark blue green stratum, shortly, or elongated radiating. Trichomes straight, rather rigid, more or less endowed with active motion; joints equal or half as long as broad, sometimes a little constricted at the dissepiments, which are delicately granulated; apex more or less attenuated, obtuse, curved or straight; cell-contents pale watery blue.

Size. Threads ·054-·006 mm. diam.

Rabh. Alg. Eur. i., 102.

Oscillatoria limosa, Hook Fl. Scot. ii., 79.

Oscillaria viridis, Kutz. Tab. Phyc. i., t. 41, f. 6. Eng. Bot. t. 2523. Johnst. Fl. Berw. ii., 264.

Oscillatoria contexta, Carm. Hass. Alg. 256, t. 71, f. 7, 4, 6. Eng. Fl. v., 376. Harv. Man. 165.

Oscillatoria tenuis, Hass. Alg. 248, t. 72, f. 1. (?) Jenn. Tunb. Wells 188. Harv. Man. 163. Grev. Fl. Edin. 303.

Mack. Hib. 239. Gray. Arr. i., 281. Eng. Fl. v., 374. Eng. Bot. ii., 2525.

In ditches, swamps, inundated places, now and then free swimming; throughout the year.

Very variable, passing into several moderately distinct varieties, of which the bright green one called *viridis* is the most beautiful, and by no means rare.

The form which Carmichael called *Oscillatoria contexta* has thus been described by him:—"Stratum of indefinite extent three feet and upwards, exceedingly thin, and peeling off in large flakes in dry weather, of a deep but shining black colour, scored or striated in all directions. These striæ are caused by thick fasciculi of filaments, shooting out either parallel to or across each other, changing their course from time to time and sending off lateral fasciculi. The filaments are rather thick about a line in length, straight. or variously curved, of a greyish green colour, and they radiate with great rapidity. A portion of the stratum, not more than a line in diameter, placed in a watch-glass filled with water, overspread the whole area of the glass with filaments in the course of a night." Hassall says of it, "the filaments are in calibre not less than those of *O. tenuis*, from which species it is distinguished chiefly by its colour."

Plate XCVI. fig. 8. Portions of trichomes × 400. *Plate XCVII, fig.* 1. Portions of trichomes of the variety *viridis* × 400.

Oscillaria antliaria. *Jurgens Alg. Exs. No.* 14.

Expanded in a gelatinous, sometimes very broad submembranaceous stratum, dark steel-blue. Trichomes rigid, straight, sometimes tranquil, sometimes oscillating, curved at the attenuated apex (curvature of 3 to 4 joints); joints equal, or nearly equal,in length and breadth (after division half as long), dissepiments distinctly granular, extreme apex obtusely rounded. Cell-contents pale steel-blue, or blue green, nearly homogenous.

SIZE. Threads ·0045-·0055 mm. diam.

Kutz. Tab. Phyc. i., t. 40, f. 6. Rabh. Alg. Eur. ii., 100. *Oscillaria parietina*, Vauch. Conf., t. 15, f. 8.

Around pumps, cisterns, &c.

Plate XCVII. fig. 2. Portions of trichomes × 400.

Oscillaria muscorum. *Carm. MSS.*

Stratum 3-4 inches, of a dark bluish-green colour, slightly lubricous, shortly radiating, creeping over mosses. Trichomes variously curved, pale blue green, joints about equal in length to their diameter.

SIZE. Trichomes ·006-·007 mm. diam.

Hook. Eng. Fl. v., 365. Harv. Man. 164. Hass. Alg. 252, t. 72, f. 12.

In rapid streams, on *Hypnum ruscifolium*, &c.

"Stratum 3 or 4 inches in extent, closely interwoven with the branches and leaves of mosses, of a bluish green colour, and slightly lubricous

Filaments a line or two in length, variously curved and radiating; striæ at the distance of a diameter from each other."—*Carmichael.*

Plate XCVIII. fig. 8. Portions of trichomes × 400, from the original specimens.

Oscillaria subuliformis. *Thw. in Harv. Phyc. Britt.*

Stratum of an intense æruginous green. Trichomes bright green, subuliform, gradually attenuated towards the apices, which are subacute and much curved; joints about three-fourths as long as broad, homogenous.

SIZE. Trichomes ·006-·007 mm. diam.

Harv. Phyc. Britt. t. 251 B. Rabh. Alg. Eur. ii., 292.

In brackish ditches. Summer and autumn.

Very bright emerald green, and certainly an attractive species.

Plate XCVIII. fig. 3. Trichomes from original specimen × 400 diam.

Oscillaria limosa. *Ag. Syst. Alg.* 66.

Trichomes rigid, straight, actively oscillating, blue-green, interwoven in a thin mucilaginous radiating green stratum, distinctly articulate, joints nearly equal or a little longer than broad (shorter after division, often half as long as the diameter), dissepiments granulated, apex obtuse, straight or curved; cell-contents pallid, homogenous or slightly granular.

SIZE. Threads ·008-·01 mm. diam.

Rabh. Alg. Eur. i., 104. Hook. Br. Fl. ii., 374.

Conferva limosa, Fl. Dan. t. 1549.

Oscillatoria limosa, Hass. Alg. 246, t. 71, f. 2. (?) Eng. Fl. v., 374. Gray. Arr. i., 280. Eng. Bot. ii., 186. Harv. Man. 162. Johnst. Fl. Berw. ii., 265. Mack. Hib. 239. Fl. Dev. ii., 56.

Oscillaria tenuis d. *limosa*, Kirch. Alg. Schles. p. 247.

There are several varieties, differing chiefly in colour, of which Rabenhorst enumerates ten.

If Hassall's figure is magnified in proportion to the rest, then his t. 71, f. 2, can scarcely be the present species, for its diameter would be equal to that of *O. Frolichii*, whereas this scarcely exceeds half that thickness. All the figures of *Oscillaria* given in Hassall's work are acknowledged to be very defective.

Plate XCVII. fig. 3. Portions of trichomes × 400. Fig. 4, portions of trichomes of the variety *chalybea* × 400.

Oscillaria irrigua. *Kutz. Phyc. Gen.* 189.

Stratum thin, expanded, compact, dark steel-blue, by oblique light purplish violet; trichomes straight, flexile, pallid then livid steel blue, a little attenuated at the apex, joints equal in length to their diameter (after division half as long) dissepiments beautifully granulated, extreme apex broadly rounded, or somewhat beaked, cell-contents homogenous or delicately granular.

Size. Threads ·0076-·01 mm.

Kutz. Tab. Phyc. i., t. 42, f. 4. Rabh. Alg. Eur. ii., 107.

On wet rocks, walls, or overrunning mosses.

The variety "subsalsa," bearded at the apex, was found on Greenwich Pier in 1861.

Plate XCVII. fig 5. Portions of trichomes × 400.

Oscillaria nigra. *Vauch. Conf.* 192, *t.* 15, *f.* 4.

Stratum more or less compact, somewhat membranaceous, often floating, steel-blue, or dark olive nearly black, with radii more or less elongated, of the same colour. Trichomes straight or slightly flexuous, obtusely rounded at the apex, or attenuated, and sometimes bearded; joints equal in length to their diameter (after division one half or one third as long); dissepiments very distinctly granulated, apiculus often straight, somewhat rostellate and bearded, rarely slightly curved; cell-contents pale olive, finely granular.

Size. Threads ·009-·01 mm. diam.

Rabh. Alg. Eur. i., 107. Kirch. Alg. Schl. 247. Harv. Man. 165. Eng. Fl. v., 376. Eng. Bot. t. 2527.

Oscillatoria nigra, Hass. Alg. 255, t. 71, f. 3. Hook. Fl. Scot. 79. Jenn. Tunb. Wells 188. Mack. Hib. 239. Gray Arr. i., 281.

Conferva fontinalis, Dillw. Conf. t. 64. Huds. Fl. Ang. 592. Lightf. Fl. Scot. 976. With. Arr. iv., 128.

In ditches and ponds.

"Stratum extensive, blackish, with a shade of green, when dry blue-black, very rapid in its growth, and sending out long, vividly oscillating rays."—*Harvey.*

Plate XCVII. fig. 6. Portions of trichomes × 400.

Oscillaria nigro-viridis. *Thwaites in Harv. Phyc.*

Stratum thin, of a dark olive green, almost black, growing upon the mud, and subsequently floating in large masses. Trichomes pale dull green, with obtuse, distinctly curved, scarcely attenuated apices; joints indistinct, about half as long as broad, cell-contents slightly granulose.

Size. Trichomes ·012 mm. diam.

Harv. Phyc. Britt. t. 251 a. Rabh. Alg. Eur. ii.. 292.

In brackish ditches. August.

Plate XCVIII. fig. 2. Trichomes of *O. nigro-viridis* × 400 diam.

Oscillaria chalybea. *Mertens, in Jurgens Algæ.*

Floating. Stratum broadly expanded, with long radii, dark blue green or steel-blue, shining; trichomes pale steel-blue, slightly flexuous, a little attenuated at the apex, joints three or four times shorter than their diameter, a little contracted at the dissepiments, which are not granulated, apiculus slightly curved, obtusely rounded, now and then rostellate, cell-contents pale steel-blue, granular.

SIZE. Threads ·0088-·01 mm. diam.

Kutz. Tab. Phyc. i., t. 40, f. 8. Rabh. Alg. Eur. ii., 108.

In still and stagnant water.

The specimens figured were collected from a tank in one of the stoves of the Royal Botanic Gardens, Regent's Park.

Plate XCVIII. fig. 1. Trichomes of *O. chalybea* × 400 diam.

Oscillaria Frolichii. *Kutz. Phyc. Gen.* 189.

Stratum dark steel-blue, or at first olive, then dark blue, often elongated, radiating, opaque, shining; trichomes nearly equal, straight; joints 2, 3, or 4 times shorter than their diameter, with a double series of granular points more or less dense at the junction, often confluent, so as to resemble a single series; apiculus broadly rounded, straight, or declined; cell-contents blue, becoming steel-blue, homogenous.

SIZE. Threads ·015-·018 mm. diam.

Kutz. Tab. Phyc. i., t. 43, f. 1. Rabh. Alg. Eur. ii., 109.

Oscillatoria mucosa, Hass. Alg. 247, t. 71, f. 1.

In ditches, pools, and boggy places, sometimes amongst mosses.

The finest of the species yet detected in Britain.

Plate XCVII. f. 7. Portions of trichomes × 400.

Oscillaria insignis. *Thwaites in Phyc. Britt.*

Stratum thin, covering decayed vegetable matter at the bottom of a ditch, with a dark-brown coating, becoming somewhat greenish in drying; trichomes very large, rather brittle, their apices rounded, somewhat oblique, and furnished with numerous motionless cilia; cell-contents distinctly granulose.

SIZE. Trichomes ·018 mm. with sheath.

Rabh. Alg. Eur. ii., 293. Harv. Phyc. Brit. ii., t. 251, f. *c*.

In a brackish ditch. November.

A portion of the trichome from the original specimen has been figured, but Professor Harvey was evidently of opinion that it was a strictly marine species. There seems at least to be no doubt that it is in reality a *Lyngbya*, allied to *L. æstuarii*, and not a true *Oscillaria*. We are indebted to Professor Percival Wright for an examination of authentic specimens of this, and several other of Harvey's species.

Plate XCVIII. fig. 4. Portion of trichome × 400.

Doubtful Species.

Oscillaria Dickiei (*Hass.*) *Rabh. Alg. Eur.* II., 113.

Stratum pale chesnut-brown, gelatinous, shining; trichomes of medium size, long, straight, fragile, with visible spaces between the joints.

SIZE. Not determined.

Oscillatoria Dickiei, Hass. Alg. 258, t. 72, f. 13.

Pools of fresh water near the sea.

The colour of this species is so peculiar as at once to distinguish it from all others which have been described. This colour is preserved in drying; the filaments are of nearly the same diameter with those of *O. tenuis*, but they preserve their calibre when dried.—*Hassall.*

Oscillaria thermalis. (*Hass.*) *Rabh. Alg. Eur.* II., 113.

Trichomes straight, rigid, fragile, green; divisions of the joints distinct, rather remote.

SIZE. Not determined.

Oscillatoria thermalis, Hass. Alg. 250, t. 72, f. 3.

In warm water.

The figures and descriptions in Hassall's work are wholly insufficient for the proper identification of this and the following species.

Oscillaria virescens (*Hass.*) *Rabh. Alg. Eur.* II., 113.

Stratum pale blue-green; trichomes of medium size, pale yellowish-green, with the joints rather distant, nearly equal in length to their diameter.

SIZE. Not determined.

Oscillatoria virescens, Hass. Alg. 250, t. 71, f. 9.

On the ground.

GENUS 102. **MICROCOLEUS.** *Desm.* (1823.)

Trichomes rigid, articulate, crowded together in bundles, enclosed in a common mucous sheath, either closed or open at the apex; sheath ample, colourless, more or less lamellose, rarely indistinct. = *Chthonoblastus*, Kutz. (1843.)

"Trichomes enclosed in a transparent sheath from which they emerge to reproduce new filaments, sheath containing several trichomes. Filaments growing in scattered creeping erect or floating wick-like bundles."—*Thuret.*

Hydrocoleum thermale Kutz., mentioned in Quart. Journ. Micr. Sci. (1867) p. 86, as having occurred in Ireland, we have never seen, and, therefore, do not know whether it should be included in *Microcoleus.*

Microcoleus gracilis. *Hass. Alg.* 261, *t.* 70, *f.* 2.

Effused broadly in a thin dark green stratum. Trichomes pale blue green, slightly curved, in fascicles densely contorted about the apex, joints 2-3 times longer than their diameter, either continuous or distinctly separated, granulated, divisions paler, nearly hyaline, a little contracted about the apex, extreme apiculus conical, now and then slightly curved, special sheath narrow, very delicate, universal sheath very thick lamellose.

SIZE. Trichomes ·0025-·003 mm.; fascicles ·09-·12 mm.

Kirch. Alg. Schl. 244.

Microcoleus marinus, Harv. Man. 168.

Chthonoblastus salinus, Kutz. Tab. Phyc. i., t. 58, f. 2. Rabh. Alg. Eur. i., 133.

Oscillatoria chthonoplastes, var. α. Eng. Fl. v., 373. Eng. Bot. ii., t. 2523. Mack. Hib. 239.

On salt marshes.

"Fronds fixed at the base, floating freely in the water, an inch long, tufted, dichotomously branched, branches slender capillary widening upwards, with club-shaped tips; colour olivaceous green or yellowish. When ruptured the branches discharge innumerable needle-shaped filaments, which, when the plant is growing, radiate and oscillate from the tips of the branches."—*Harvey.*

Plate XCIX. fig. 1. End of fascicle of trichomes with sheath × 400.

Microcoleus chthonoplastes. *Thur. in Ann. Sci. Nat.* (1875) *p.* 377.

Stratum thin, or thicker and rather compact, dingy æruginous green; trichomes slightly flexuous, equal, twisted, in dense fascicles, joints nearly twice as long as their diameter, rather remote from each other, leaving a hyaline space between them, apiculus attenuated, rather elongated; special sheath very delicate, universal sheath narrow, scarcely lamellose.

SIZE. Trichomes ·0035-·004 mm.; fascicles ·03-·035 mm.

Chthonoblastus Lyngbyei, Kutz. Tab. Phyc. i., t. 58, f. 1.

Microcoleus anguiformis, Hass. Alg. 261, t. 70, f. 1. Kirch. Alg. Schl. 244.

Chthonoblastus anguiformis, Kutz. Tab. Phyc. i., t. 57. Rabh. Alg. Eur. ii., 133. Harv. Phyc. Britt. t. 249.

On the naked ground, by roadsides, &c.

Plate C. fig. 1. Fascicle of trichomes with sheath × 400.

Microcoleus terrestris. *Desm. Pl. Crypt. Exs.* I., *No.* 55.

Stratum more or less expanded, deep blue green or steel blue, or olive, becoming brownish, membranaceous, mucilaginous; trichomes equal, collected in filiform fascicles, sometimes much elongated, extruding from the opening of a common sheath in a penicillate manner, joints equal in breadth and length, dissepiments granulated, apiculus acute, straight.

SIZE. Trichomes ·005–·006 mm.; fascicles ·075–·08 mm.

Kirch. Alg. Schl. p. 244.

Chthonoblastus repens, Kutz. Tab. Phyc. i., t. 54. Rabh. Alg. Eur. ii., 132.

Microcoleus repens, Hass. Alg. 260, t. 70, f. 3. Jenner Tunb. Wells 188. Harv. Man. 168.

Conferva vaginata, Eng. Bot. i., t. 1995.

Oscillatoria chthonoplastes, var. β. Eng. Fl. v., 373. Mack. Hib. 239.

Vaginaria vulgaris, Gray. Arr. i., 280.

Vaginaria chthonoplastes, Grev. Fl. Ed. 305.

On moist naked ground.

"The frond consists of numerous curled branches diverging from a centre in a starry manner, and gradually tapering from a broad base to a fine point, containing numerous deep green filaments, which radiate and oscillate from the tips, and, on laceration, issue in bundles."—*Harvey.*

Plate XCIX. fig. 2. End of fascicle of trichomes with sheath × 400.

GENUS 103. **INACTIS.** *Kutz.* (1843.)

Trichomes vaginate, indistinctly articulate, parallel and fastigiate, now and then dichotomous, very densely aggregated and agglutinated in a pulvinate thallus.

"Filaments bundled, erect, growing in small rounded tufts, or in a felt-like turf of indefinite extent. Trichomes very slender."—*Thuret.*

Inactis Cresswelli. *Thur. in Ann. Sci. Nat.* (1875) 377.

Forming convex roundish or oval patches, which become confluent for several inches; filaments hyaline, yellowish or greenish olive, collected into dense rope-like branching bundles, which are fastigiate; trichomes exceedingly slender, once or twice divided in a dichotomous manner.

SIZE. Trichomes ·0025 mm. diam.

Schizothrix Cresswelli, Harv. Phyc. Britt. t. 160. Rabh. Alg. Eur. ii., 268.

Spreading over the surface of soft sandstone rocks exposed to the drip of fresh water.

"Mr. Cresswell states that it grows at the very top of high water mark, in situations where it is exposed to the continual drip of fresh water falling from high mural cliffs, and that it is most luxuriant where the drip falls from the greatest height, which in the station observed is about fifty feet."—*Harvey.*

Plate C. fig. 2. *a*, portion of fascicles of trichomes × 100; *b*, trichomes × 400.

Inactis tinctoria. *Thur. Ann. Sci. Nat.* (1875) 377.

Fasciculate cæspitose, dingy brown becoming olive; trichomes single or many associated in one sheath, joints equal in length to their diameter or a little longer; sheaths broad, colourless, distinctly lamellose, even.

SIZE. Trichomes ·002 mm. diam.

Hydrocoleum tinctorium, Br. Rabh. Alg. Eur. ii., 294. Ralfs Exs., No. 19.

On aquatic plants.

Mr. Marquand says that he has never seen it growing on any other plant than *Scirpus fluitans*, and he adds:—"I have never seen a vestige of green about it in its natural condition during any period of its existence; when decaying it becomes pale, and eventually almost white; when in its best condition it is of a rich chesnut brown. In drying it turns green. In its best condition, when placed in water for twelve hours, it will dye it of a clear rosy purple."

The following description of this plant has been kindly furnished by Mr. Ralfs:—"In rapid streams on leaves of aquatic plants, it forms a minute continuous covering on leaves of aquatic grasses, giving them a feathery appearance. Colour varying from nearly black to pale reddish brown; in drying and decay it turns green, and gives a purplish stain to paper. Filaments somewhat mucous, very slender, nearly colourless, cohering at base in fascicles containing 3 to 8 filaments, and by their separation at intervals, simulate branches, and thus gradually reduce the number cohering until they ultimately separate into single ones. The filaments thus appear comparatively stout at the base and gradually to become attenuated upwards. As the apparent branches are given off this is more especially the case, because, from their pale colour, indistinct endochrome, and closeness of connection, it requires care to detect that they are really fascicled. Besides the elongated filaments there are numerous short ones at the base, together with crowded, somewhat thicker clavate erect bodies. Whether these are the fructification or rudimentary fascicles I am unable to determine."—*Ralfs.*

Plate C. fig. 3. Upper portion of fascicle of trichomes × 400.

GENUS 104. **LYNGBYA,** *Ag. em. Thuret.* (1875.)

Filaments enclosed singly in a sheath, simple, or only exceptionally exhibiting the beginning of ramification where the trichome issues from the side of the sheath; often combined in a membranaceous stratum.—including *Phormidium* Kutz.

Lyngbya æstuarii. *Lieb. Danska Algflora.* (1839.)

Trichomes rigid, flexuously curved, blue green, granular, densely interwoven in dark blue green tufts; joints 3-6 times shorter than their diameter; scarcely constricted; sheaths pellucid, hyaline, becoming brownish, at first scarcely lamellose, at length when old becoming distinctly lamellose.

SIZE. Trichomes ·025-·03 mm. diam., without sheath.

Lyngbya æruginosa, Ag. Syst. p. 74. Rabh. Alg. Eur. ii., 138.

Lyngbya β. ferruginea, Harv. Phyc. Britt., t. 311.

Lyngbya curvata, Rabh. Alg. Eur. ii., 137.

Lyngbya majuscula, Cocks Brit. Seaweeds No. 365.

In brackish water.

Plate CI. fig. 1. *a*, portion of filament × 160 diam. *b*, extremity of filament, with portion of trichome escaped × 160 diam. *c*, portion of filament with the trichome divided into hormogones × 330. *d*, *e*, hormogones × 330, all after Thuret.

Lyngbya littoralis. (*Carm*).

Stratum thin, submembranaceous, mucilaginous, blue green, shortly radiating; trichomes rigid, flexuous, vividly oscillating, equal; joints 4-5 times as broad as long, constricted at their junction and hyaline, dissepiments granulated, extreme apiculus straight, broadly rounded, paler; cell contents pale blue green, very delicately granular.

SIZE. Threads ·013-·015 mm. diam.

Oscillatoria littoralis, Carm. Alg. App.; Eng. Fl. v., 375. Harv. Man., 165. Harv. Phyc. Britt. t. 105, fig. *a*.

In brackish water, and in rock pools by the shore.

"Stratum exceedingly thin, slimy, bullated by the extrication of air-bubbles, of a dark green colour, spreading to an indefinite extent over the muddy bottom of the pool."—*Carm.*

Plate CII. fig. 1. Portions of trichomes × 400, from the original specimens.

Lyngbya ochracea. *Thur. Ann. Sci. Nat.* (1875) 377.

Forming cloud-like floating fragile masses of an ochrey colour. Trichomes very slender, scattered; joints scarcely visible.

SIZE. Trichomes ·002 mm. diam., including sheath.

Kirch. Alg. Schl. 241.

Leptothrix ochracea, Kutz. Tab. Phyc. i., t. 61, fig. 1.

Conferva ochracea, Dillw. Conf. t. 62.

Oscillatoria ochracea, Grev. Fl. Edin. 304. Harv. Man. 167. Eng. Fl. v., 378. Eng. Bot. ii., 187. Johnst. Fl. Berw. ii., 264. Mack. Hib. 240. Fl. Dev. ii., 57. Gray. Arr. i., 281.

In boggy pools.

This species is common in boggy pools "where it occurs in cloud-like masses, scarcely to be called strata, the filaments are very slender and scattered without order. Dillwyn's figure incorrectly represents the filaments as branched."

Plate CII. fig. 4. Trichomes × 400.

Lyngbya inundata. (*Kutz.*)

Deep blue green, with a whitish grumous membranaceous substratum, trichomes curved rather rigid, pale blue green, rarely fasciculate, sheaths narrow, joints shorter than their diameter, dissepiments naked (not granulated), extreme apex straight obtuse.

SIZE. Trichomes ·004 mm. diam.

Phormidium inundatum, Kutz. Tab. Phyc. i., t. 45, f. 3. Rabh. Alg. Eur. ii., 116.

Oscillaria autumnalis, Carm. (partly). Harv. Man. 165. Hass. Alg. 251, t. 72, f. 7.

Margin of ditches, by moist roads, on flowerpots, &c.

"Stratum extensively spreading, very dark and lubricous, glossy when dry, filaments remarkably pale, striæ not very evident, a variety is common on clayey ground, which occurs in small circular patches about an inch or two in diameter."—*Harvey*.

The filaments in Carmichael's specimens are not more than half the diameter of those in *Lyngbya vulgaris*, to which species they are usually referred.

Plate CII. fig. 8. Portions of trichomes × 400.

Lyngbya vulgaris. *Kirch. Alg. Schl.* 242.

Stratum thin, more or less expanded, mucilaginous, dark coloured (olive, brown, yellow, steel blue or purplish) opaque or shining, by age becoming thickened, but rarely lamellose, and without a substratum being formed; trichomes straight, rigid, distinctly vaginate, joints equal to their diameter or shorter, dissepiments delicately granulated, apex evidently attenuated, now and then somewhat curved, naked.

SIZE. Trichomes ·0045-·0065 mm. with sheath ·006-·009 mm.

Phormidium vulgare, Kutz. Tab. Phyc. i., t. 46, fig. 4. Rabh. Alg. Eur. ii., 119.

Oscillatoria autumnalis (partly), Eng. Fl. v., 376. Eng. Bot. ii., 187. Jenn. Tunb. Wells 188. Grev. Fl. Edin. 305. Harv. Man. 165, Mack. Hib., 239.

Conferva decorticans, Dillw. Conf. t. 26.

Oscillatoria decorticans, Grev. Fl. Edin. 304. Eng. Fl. v., 375. Eng. Bot. ii., 187. Jenner Tunb. Wells 188. Harv. Man. 164. Mack. Hib. 239. Hass. Alg. 257, t. 71, f. 10.

Humida decorticans, Gray. Arr. i., 282.

On moist naked ground after rain.

Plate CII. fig. 5. Portion of trichomes × 400; *fig.* 6, variety *myochroum* × 400.

Lyngbya papyrina. *Kirch. Alg. Schl.* 241.

Forming a thin papery stratum, sometimes shortly radiating, with a pallid or brownish fibrillose substratum, formed from the interlaced empty sheaths, trichomes equal, joints nearly equal or a little shorter than their diameter, granulated at their junction, apex obtuse, straight, naked.

Size. Trichomes ·005-·006 mm., with sheath ·0075-·009.

Oscillaria papyrina, Bory. Dict. Sci. Nat.

Phormidium papyrinum, Kutz. Tab. Phyc. i., t. 41, fig. 3.

Phormidium papyraceum, Rabh. Alg. Eur. ii., 125.

Oscillatoria spadicea, Carm. Hass. Alg. 255, t. 71, f. 5, t. 72, f. 5. Eng. Fl. v., 378. Harv. Man., 167.

In streams, torrents, aqueducts, canals, &c.

The form met with by Carmichael was growing on damp mossy earth. He says "It occurs in a very thin dark green stratum spreading to the extent of several feet, and is hardly to be distinguished from the mossy earth on which it grows."

Plate CII. fig. 7. Portions of trichomes × 400.

Lyngbya rupestris. (*Ag.*)

Stratum compact, rather velvety, gelatinous, lamellose, very shortly radiating, bright blue green or becoming dark steel blue, the lower strata becoming discoloured and fibrillose; trichomes rigid, rather flexuous, a little torulose towards the apex, joints equal in length and breadth, very finely punctate, dissepiments granulated, extreme apex paler, sometimes bearded.

Size. Trichomes ·007-·008 mm. diam.

Phormidium rupestre, Kutz. Tab. Phyc. i., t. 49, fig. 4. Rabh. Alg. Eur. ii., 122.

Oscillaria rupestris, Ag. Syst. p. 63. Hass. Alg. 254., t. 72, f. 11. Grev. Sc. Crypt. Fl. t. 246. Eng. Fl. v., 377, Harv. Man. 166.

On moist rocks where the water is constantly trickling, and in mountain streams.

Carmichael writes of his specimens, "Stratum extensive, slimy, remarkably tough and elastic, black on the surface, ash-coloured underneath, when dry blackish green. Filaments pale green, straight, or variously curved, radiating, but not equally in all directions."

Plate CI. fig. 2. Portions of trichomes × 400.

Lyngbya corium. (*Ag.*)

Stratum toughly membranaceous, compact, brown, steel blue or greenish, interwoven forming a mucilaginous membranaceous substratum ; trichomes straight or flexuous, rather rigid, olive or brown, then yellowish, joints not more than half as long as broad, beautifully transversely punctate, granulated, apex conically attenuated, bearded.

SIZE. Trichomes ·007-·008 mm. diam.

Phormidium corium, Ag. Syst. p. 64. Rabh. Alg. Eur. ii., 126.

Oscillatoria corium, Hass. Alg. 252. Eng. Fl. v., 377. Harv. Man. 166. Eng. Bot. ii., 187. Grev. Fl. Edin. 303. Mack. Hib. 240.

On the rocky bottom of alpine rivulets.

"Stratum thick, tough, dull brownish, occasionally streaked with pale green, which in some varieties is the prevailing colour, slightly glossy when dry ; filaments slender. In some situations it radiates in fascicles from its whole upper surface; in others it is found almost denuded of radii, and forming a compact leathery stratum."—*Harvey*.

Plate CII. fig. 2. Portions of trichomes × 400.

Lyngbya turfosa. (*Carm.*)

Forming a thick intensely green stratum, with a tough, slimy, ochre-coloured substratum. Trichomes slender, more or less curved, and mostly hyaline at the point; joints not more than half as long as broad, distinct.

SIZE. Trichomes ·008 mm. diam.

Oscillatoria turfosa, Carm. in Harv. Man. 164. Hass. Alg. 253, t. 72, f. 6.

On floating sods in old turf pits.

"This species grows in a thick, intensely green layer, over a tough, slimy, ochre-coloured substratum. It entirely enveloped the sods, some of which were a foot and a-half in diameter. Filaments very slender, more or less curved, and mostly hyaline at the point."—*Carm.*

Plate CII. fig. 3. Portions of trichomes × 400, from the original specimens.

Lyngbya subfusca. (*Ag. Syst. p.* 64.)

Substratum velvety, fibrillose, tawny, becoming yellowish, forming a firm compact stratum, of a violet or steel blue colour, changing to brownish; trichomes rigid, straight, joints about half as long as broad, with a double row of points at the commissure, apex rather obtuse, naked.

SIZE. Trichomes ·008 mm. diam. Thinner form, trichomes ·006-·007 mm. diam.

Phormidium subfuscum, Rabh. Alg. Eur. ii., 125.

On stones in mountain streams.

Plate CI. fig. 3. *a,* portions of trichomes × 400, from Scotch specimens. *b,* portions of trichomes from a thinner form × 400.

GENUS 105. **SYMPLOCA.** *Kutz.* (1843.)

Trichomes articulate, simple, or only exhibiting the beginning of ramification, more or less distinctly vaginate, ascending from a prostrate base, agglutinated together in erect or anastomosing fascicles, or wick-like bundles, more or less procumbent, coalescing, and often involved in a matrical gelatin.

Symploca lucifuga, *Harv. in Eng. Fl.* v., 373.

Dark æruginous green, fascicles about two lines high, approximate, subuliform, apex at length penicillate; trichomes single or twin, æruginous, joints equal or a little longer than broad, distinctly granulated, sheaths broad, pellucid, colourless, quite smooth.

SIZE. Trichomes ·0035-·004 mm. diam., including sheath ·01 mm.

Rabh. Alg. Eur. ii., 155.

Oscillatoria lucifuga, Hass. Alg. t. 65, f. 5, 6. Harv. in Eng. Fl. v., 373.

Calothrix lucifuga, Carm. MSS.

On pastures and heaths, on decayed alder trunk.

"Stratum spreading dull blackish green, bristling all over with minute erect fascicles about one third of a line high. Filaments thickish, flexuous, strongly agglutinated together, annulated within, pale yellowish."—*Harvey.*

Plate CIII. fig. 2. *a,* portion seen with a pocket lens. *b,* trichomes × 400.

Symploca Ralfsiana, *Kutz. Tab. Phyc.* I. *t.* 74, *f.* 4.

Steel blue or olive becoming blackish, fascicles as much as an inch high, densely aggregated, often coalescing, subuliform, straight, trichomes pale blue-green or steel blue, densely agglutinate, distinctly articulated, somewhat beaded about the apices, joints equal or a little longer than broad, cell-contents granular, sheaths broad, pellucid, homogenous.

SIZE. Trichomes ·0035–·004 mm. diam.

Rabh. Alg. Eur. ii., 157.

Oscillaria Friesii, Harv. Eng. Fl. v., 373. Harv. Man. 162. Hass. Alg. p. 259. Mack. Hib. 238.

Oscillatoria Bangii, Carm. Grev. Fl. Ed. 303.

Scytonema Bangii, Lyngb. Hydro. Dan. t. 28.

Over running mosses in shady sub-alpine situation.

" Stratum 2-3 inches broad, bright æruginous green. Filaments closely interwoven into erect elongated tooth-like fascicles, an inch or more in height, pale green under the microscope, annulated within, with a broad limb or border, well marked by its erect spinulose habit."—*Harvey*.

Plate CIII. fig. 1. *a*, portion as seen with a pocket lens. *b*, trichomes × 410.

GENUS 106. **PLECTONEMA.** *Thur.* (1875.)

Filaments branched, ramifications produced by the branching of the trichome outside of the sheath, very irregular, and often germinate as in *Scytonema*.

Plectonema mirabile, *Thur. Ann. Sci. Nat.* (1875) 377.

Forming floccose tufts, blue-green, now and then turning brownish, trichomes with pseudo-branches usually in pairs and parallel; joints shorter than their diameter, granular sheath narrow, colourless or yellowish, quite smooth.

SIZE. Filaments ·021 mm. with sheath.

Born. and Thuret, Notes Alg. ii., p. 135, t. 33.

Conferva mirabilis, Dillw. Conf. t. 96.

Calothrix Brebissonii, Kutz. Tab. Phyc. ii., t. 30, f. 4.

Calothrix atrovirens, Harv. Man. 159.

Calothrix mirabilis, Ag. Syst. 72. Rabh. Alg. Eur. ii., 271. Hass. Alg. 243, t. 69, f. 1. Eng. Fl. v., 369. Harv. Man. 159.

Elisa mirabilis, Gray. Arr. i., 283.

In small streams.

Plate CIV fig. 1. *a*, portion of trichome × 330. *b*, portion with a single branch × 330 after Thuret.

Plectonema Kirchneri, *Cooke, Grevillea* xi., *p.* 75.

At first attached, but soon floating, and forming subglobose woolly tufts, of a dark bluish green, changing to olivaceous. Tufts from half an inch to an inch in diameter. Trichomes radiating, with simple (rarely germinate) branches ; joints one third or one fourth as long as broad.

SIZE. Filaments ·012-·015 mm. diam., with sheath.

Plectonema mirabile, Kirch. Alg. Schles. p. 229 (scarcely of Thuret).

In ornamental water. Pleasure grounds, Kew.

The filaments are much thinner than in *P. mirabile* and the branches issue singly from the sheath, and not in pairs, as in that species. From the dimensions given by Kirchner it seems probable that this is the species to which he has given the name of *P. mirabile.*

Plote CIV. fig. 2. *a,* tuft, natural size. *b,* trichomes × 400.

FAMILY III. SCYTONEMEÆ.

Filaments with lateral ramifications in which some of the cells change into heterocysts.

This family is divisible into two sections according to the direction of the multiplication of the cells.

* Cells only multiplying in the direction of the length of the filament.

Scytonema, Petalonema, Symphyosiphon, Tolypothrix, Cystocoleus.

** Cells multiplying as well in the direction of the breadth of the filament, at least where the branches, which are always produced by lateral multiplication, originate.

Stigonema, Fischera, Haplosiphon.

The last section includes many very doubtful forms, which will probably, as their development becomes better known, be transferred to Lichens, of which they are presumably an imperfect condition.

GENUS 107, **SCYTONEMA.** *Ag.* (1824.)

Sheath enclosing a single trichome, ramifications produced by the deviation of the trichome, which emerges from the side of the sheath. Ramifications usually geminate, produced by a fold of the trichome which ruptures outside of the sheath, and gives origin to two filaments given off at a right angle. Heterocysts scattered here and there in the trichome, without any evident relation to the ramifications.

Scytonema myochrous. *Ag. Syst. p.* 40, *No.* 13.

Stratum thin, woolly, dark brown (now and then rather silky); trichomes very thick, brown, lucid, slightly curved, ascending, blue-green within, reddish at the apex (5-6 terminal joints), distinctly articulate, pseudo-branches for the most part in pairs, sometimes very long, flaccidly erect, about half the thickness of the trichomes; sheath of the trichomes thick, distinctly lamellose, firm, beautiful yellow-brown, surface quite smooth, that of the branches paler, often colourless at the tips, closed and obtusely rounded, heterocysts oblong or sub-cylindrical, colourless, about equal to the inner diameter of the trichomes.

Size. Cells ·01 mm. diam., with sheath ·03 mm. diam.

Rabh. Alg. Eur. ii., 254. Hass. Alg. 237, t. 68, f. 2. Jenn. Tunb. Wells, 188. Gray. Arr. i., 285. Eng. Bot. ii., t. 2515, t. 2516. Kirch. Alg. Schl. 225. Harv. Eng. Fl. v., 365. Harv. Man. 155. Mack. Hib. 236.

Conferva myochrous, Dillw. Conf. t. 19. Eng. Bot. i., t. 1555.

On moist rocks.

Plate CV. fig. 1. *a*, threads magnified about 60 diam.; *b*, portion of same × 400; *c*, hormogones × 400.

Scytonema natans. *Breb. in Kutz. Tab. Phyc.* II., *t.* 22, *f.* 1.

Floccose tomentose, green then brown or olive, trichomes slender, elongated, becoming brownish, internally æruginous green, distinctly articulate, joints nearly equal, granular, pseudoramuli often in pairs, very slender, more or less distant, very shortly articulated, sheaths firm, lamellose, yellow or brownish, rarely uncoloured, branches paler, or colourless, indistinctly lamellose, heterocysts interspersed, oblong, or ovoid, pellucid.

Size. Threads with sheath ·025 mm., without sheath ·007 mm.

Rabh. Alg. Eur. ii., 253. Kirch. Alg. Schl. 224.

In stagnant water.

Plate CV. fig. 2. Portion of trichome with sheath × 400 diam.

Scytonema cinereum. *Meneg. in Kutz. Spec.* 303.

At first pulvinate, cinereous green, then confluent, forming a more or less tomentose pulverulent stratum (becoming pale blue when dry), now and then violet or purplish; trichomes very fragile, elongated, flexuose and curved, loosely interwoven, sparingly branching, indistinctly articulate, internally dingy, æruginous green, joints shorter than broad; sheaths thick, golden brown, often encrusted with deposit of lime.

SIZE. Trichomes ·008 mm., including sheath ·01 mm.

Kirch. Alg. Schl. 225. Rabh. Alg. Eur. ii., 247.

Scytonema Julianum, Wittr. & Nordst. Alg. Exs., No. 273 a.

Drilosiphon muscicola, Kutz. Sp. 302.

Oscillaria cyanea, Hass. Alg. 248. Eng. Fl. v., 374. Harv. Man. 163.

Conferva cyanea, Eng. Bot. ii., t. 2578.

Humida cyanea, Gray. Arr. i., 282.

On walls, stones, overrunning moss, &c.

Found on the walls of warm houses in the Royal Botanic Gardens at Kew, and in Regent's Park. This is evidently the *Conferva cyanea* of English Botany found on damp walls in churches, &c. "On the wall it is conspicuous for its light sky-blue colour, like some sort of *Mucor*. Under a high magnifier, and when moistened, it is found to consist of minute even simple entangled threads, coated with a frequently interrupted covering of a dull glaucous green hue, under which the thread itself appears of a lighter glaucous bluish colour, very even in thickness, and surface consisting of scarcely distinguishable joints about as broad as they are long."—*Smith.*

Bornet and Thuret refer this to a variety of *Scytonema Hoffmanni*, whilst Kirchner retains Meneghini's specific name, which Thuret thinks to belong to *Scytonema ocellatum*, Lyngbye.

Plate CVI. fig. 1. *a*, trichomes × 400; *b*, portions of same × 400; *c*, hormogones × 400.

Scytonema interruptum. *Thw.*

Intense blue-green, forming a stratum of the same colour; sheath cellular, and furnished throughout its entire length with numerous branched and anastomosing rootlets; trichomes distinctly annulate, interrupted here and there by heterocysts, branches in pairs arising from the protruded trichome.

SIZE. Nowhere stated.

Rhizonema interruptum, Thwaites in Eng. Bot. ii. Supp., t. 2954.

Calothrix interrupta, Carm. Eng. Fl. v., 368. Harv. Man. 158.

Stigonema interruptum, Hass. Alg. 229, t. 69, f. 2.

In wet heathy places, coating mosses, &c.

We have seen no specimen of this, which is evidently a close ally of *S. cinereum*. The figure is reproduced from English Botany.

Plate CVI. fig. 2. *Scytonema interruptum*, after the figure t. 2954, English Botany. Considerably magnified, presumably about 360 diam.

Genus 108. **PETALONEMA.** *Berk.* (1832.)

Trichomes enclosed in a very broad striate membranous sheath, which forms a transparent layer, resembling a hyaline wing.

Threads as in *Scytonema*, with the sheath very broad, forming a transparent layer around the trichome.

Petalonema alatum. *Berk. Glean. t. 7, f.* 2.

Forming a thin brown stratum. Trichomes small, a few lines only in length, winged, obtuse, with numerous striæ, when taken in conjunction with the wings or membranous expansions, they are linear and plane. Each wing is about thrice the breadth of the proper filament, of a white colour, somewhat transparent, of a bright yellow next the filament, and exhibiting under a favourable light a numerous series of transverse lines or folds. Endochrome of the central thread greenish and septate.

Size. Trichomes ·01 mm., with sheath from ·05 to ·12 mm.
Hass. Alg. 238, t. 68, f. 6. Harv. Man. 168.
Arthrosiphon alatus, Rabh. Alg. Eur. ii., 265.
Arthrosiphon Grevillei, Kutz. Sp. Alg. 311. Fischer Nost. f. 10.
Oscillatoria alata, Grev. Sc. Crypt. Flora, t. 222.

On rocks exposed to the trickling of water.

Plate CVII, fig. 1, Upper portion of trichome with sheath × 400 diam.

Genus 109. **SYMPHYOSIPHON.** *Kutz.* (1843.)

Trichomes as in *Scytonema*. Filaments agglutinated in erect wick-like bundles.

Symphyosiphon Hoffmanni. *Kutz. Tab. Phyc.* II., *t.* 43, *f.* 3.

Terrestrial, resembling a *Symploca* in habit. Tufts small, ascending, dark brown; trichomes simple, erect, loosely collected in pointed fascicles, internally pale æruginous green, sometimes interrupted, joints delicately granulose, inferior cylindrical, thin, superior thicker and more or less swollen. Sheath firm, broad, attenuated upwards, rarely acute, colourless, or yellowish towards the base. Heterocysts intercalated, globose, hyaline.

Size. Trichomes ·01 mm. diam., with sheath ·012–·014 mm.
Scytonema Hoffmanni, Agardh Syst. p. 40. Rabh. Alg. Eur. ii., 259.

On naked ground, overruning mosses, &c.

Found in some quantity in one of the stoves of the Royal Botanic Gardens, Regent's Park, forming a dark velvety stratum on the stones, walls, &c.

Plate CVII. fig. 2. *a*, slightly enlarged, as seen by aid of a pocket lens; *b*, trichomes × 400; *c*, portion of same; *d*, hormogones × 400.

GENUS 110. **TOLYPOTHRIX.** *Kutz.* (1843.)

Trichomes spuriously branched, pseudo-branches spreading. Ramifications rarely geminate, oftener solitary, and originating at a point where the continuity of the trichome is interrupted by heterocysts, one or several heterocysts placed directly above each branchlet.

Tolypothrix flaccida. *Kutz. Phyc. Gen., p.* 228.

Cæspitose, dark blue-green, trichomes and pseudo-branches elongated, flaccid, arising from a prostrate base, internally pale blue-green, either interrupted or torulose, distinctly articulate (when treated by iodine), joints a little shorter than broad, sheaths colourless, hyaline, rather broad, heterocysts towards the base, subglobose or oblong, two or three together, colourless.

SIZE. Trichomes ·01 mm.

Rabh. Alg. Eur. ii., 227. Kutz. Tab. Phyc. ii., t. 32, f. 2.

In pools, &c.

Plate CVIII. fig. 1. Portions of trichomes × 400 diam.

Tolypothrix distorta. *Kutz. Tab. Phyc.* II., *t.* 33, *f.* 5.

Cæspitose floccose, bright blue-green, now and then becoming pale, trichomes and pseudo-branches very loosely interwoven, internally blue-green, sometimes apparently continuous, sometimes distinctly articulate; joints equal or a little shorter than their diameter; sheaths broad, colourless, rarely pale yellow; heterocysts at the base, or interjected, subglobose or oblong, often 2-3 together.

SIZE. Trichomes ·012 mm.

Rabh. Alg. Eur. ii., 275. Kirch. Alg. Schl., 228.

Conferva distorta, Dillw. Conf. t. 21. Eng. Bot. t. 2577.

In swamps.

"Found occasionally in boggy pools, growing on thick continuous tufts, on decaying grass, and about the stems of aquatic plants, upon small fragments of which it often floats in the autumn on the surface of the water."

Plate CVIII. fig. 2 Portion of trichome with hormogone × 400 diam.

Tolypothrix ægagropila. *Kutz. Tab. Phyc.* II., *t.* 32, *f.* 3.

Tufts an inch or more broad, somewhat rounded, bright blue green or greenish olive; trichomes and pseudo-branches loosely interwoven, internally pallid blue green, continuous or distinctly articulate, joints equal or a little longer than their diameter; sheaths narrow, hyaline, colourless, heterocysts 2 or 3 (rarely more) in a series, oblong, hyaline.

SIZE. Trichomes ·01-·012 mm.

Rabh. Alg. Eur. ii., 274. Kirch. Alg. Schl., 227.

Tolypothrix punctata, Hass. Alg. 240, t. 69, f. 3.

In standing pools.

Plate CIX. fig. 1. Portion of trichome with hormogones × 400; *b*, *c*, hormogones after Thuret; *d*, *e*, spores, after Borzi.

var. *e*, **pygmæa.** *Kutz.*

Tufts small, blue green or brownish, trichomes and pseudo-branches slender, very losely interwoven, joints a little shorter than broad, sheaths narrow, colourless or yellowish.

SIZE. Trichomes ·007-·008 mm, with sheath ·01 mm.

Kirch. Alg. Schl., 228.

Tolypothrix pygmæa, Kutz. Tab. Phyc. ii., t. 31, f. 4. Rabh. Alg. Eur. ii., 275.

Plate CIX. fig. 2. Portion of trichomes with hormogones × 400.

var. *f*, **muscicola.** *Kutz.*

Cæspitose, blue green or brownish, trichomes and pseudo-branches thicker, elongated, loosely intricate, distinctly articulated, points a little shorter than broad, sheaths very delicate.

SIZE. Trichomes ·008-·011 mm.

Kirch. Alg. Schl., 228.

Tolypothrix muscicola, Kutz. Tab. Phyc. ii., t. 31, f. 5. Rabh. Alg. Eur. ii., 275.

On mosses, &c.

Tolypothrix coactilis. *Kutz. Tab. Phyc.* II., *t.* 32, *f.* 1.

Fasciculate, cæspitose, green then brightly æruginous, trichomes and pseudo-branches slender, internally pallid, æruginous, sometimes distinctly, sometimes indistinctly articulate, granulose, joints about half their diameter in length; sheaths very narrow, very thin, homogenous, colourless, hyaline; heterocysts oblong, twin or ternate, colourless.

SIZE. Trichomes ·01 mm., with sheath a little more.

Kirch. Alg. Schl., 228. Rabh. Alg. Eur. ii., 274.

Tolypothrix distorta, Hass. Alg. 240, t. 69, f. 4. Eng. Bot., t. 2521. Ralfs. Alg. Ex. No. 20.

Conferva distorta, Dill. Conf., t. 22, *f.* A. E
Calothrix distorta, Harv. Man. 158. Mack. Hib. 237.
Elisa distorta, Gray. Arr. i., 282.

In ponds and lakes.

Plate CIX. fig. 3. Portions of Trichomes × 400.

Tolypothrix cirrhosa. (*Carm.*)

Floating cæspitose, olive, or blue-green, becoming brownish; trichomes nearly simple, rather stout, distinctly articulate, pallid blue-green, joints finely granular, one-half or one-third as long as broad; sheaths moderately narrow (rather broad in some of the older trichomes), indistinctly lamellose, smooth; heterocysts scattered.

SIZE. Trichomes ·012-·014 mm., with sheath ·02-·025 mm.

Scytonema cirrhosum, Carm. Eng. Fl. v., 366. Harv. Man., 155 (not of Eng. Bot. ii., t. 2920).

Arthronema cirrhosum, Hass. Alg. 238, t. 68, f. 7. Rabh. Alg. Eur. ii., 267.

In mountain lakes.

"It forms flexuous tufts of brown, very slender threads, proceeding in fascicles from membranous sub-erect sheaths, and containing a single row of cells scarcely so long as broad."—*Carm.*

Plate CVIII. fig. 3. Portions of trichomes × 400; *a*, hormogone × 400.

APPENDIX.

Although included by Thuret and Bornet, and also by Kirchner, with Algæ, it can scarcely be doubted that all the members of the genera *Stigonema* (or *Sirosiphon*) and *Hapalosiphon* must be transferred to the Lichens. They are included here in the form of an appendix, for the satisfaction of students, who would naturally expect some reference to them in a work of this kind. At the same time we have availed ourselves of the opportunity to add figures, and descriptions, of two or three uncertain species, which have been recorded as British, under new and unknown genera.

GENUS 111. **STIGONEMA.** *Ag.* (1824.)

Cells of the trichome often geminate or ternate, in consequence of their lateral multiplication, or even forming transverse, several-celled bands. Sheath large. Cells surrounded with a thick membrane, very prominent in the old filaments. Hormogones originating in lateral branchlets formed of a single row of cells.

Stigonema ocellatum. *Thur. Ann. Sci. Nat.* 1875, I., 377.

More or less expanded, woolly-tomentose, dark olive brown, cells of the trichome for the most part biseriate, sub-globose, or oblong-compressed, equal or one-third as long as broad, filled with a granular blue-green plasma; sheaths very thick, lamellose, dark golden brown, external stratum now and then paler, cells of the branches for the most part uniseriate, ocellate, sometimes much elongated, apex obtuse, rounded, seldom again branched, sheaths colourless or yellowish, quite smooth.

SIZE. With sheath about ·04 mm. Cells ·01-·012 mm.

Kirch. Alg. Schl. 230.

Sirosiphon ocellatus, Kutz. Tab. Phyc. ii., t. 37, f. 2. Rabh. Alg. Eur. ii., 286.

Hassallia ocellata, Hass. Alg. t. 67, f. 2, 7, 6. Fischer Nost., fig. 11.

Conferva ocellata, Dillw. Conf. t. D. Eng. Bot. i., t. 2530.

Scytonema ocellatum, Harv. Eng. Fl. v., 364. Harv. Man. 154. Grev. Fl. Ed. 302. Gray. Arr. i., 285. Eng. Bot. ii., t. 2514.

On inundated ground, in swamps and moors.

Plate CX. fig. 2. Portion of extremity of trichome × 400.

Stigonema Bouteillii. (*Breb. Ann. Sci. Nat.*)

Tufts small, immersed, cushion-like and rounded, dark brown, trichomes very short, variously curved and contorted, olive, or golden brown, sparsely branched, sometimes simple, internally sometimes interrupted, formed from one series of cells one-third or one-fourth as long as broad, branches unilateral, very short, arched, sheaths narrow, colourless or very pale yellow, hyaline and even, or with the outer stratum falling away in fibrils.

SIZE. Trichome ·04-·06 mm. Cells ·01, with envelope ·02 mm.

Sirosiphon Bouteillii, Breb. & Desm. in Ann. Sci. Nat. ser. 4, Vol. iv., p. 2.

On calcareous rocks and chalky cliffs.

Plate CX. fig. 3. Portion of trichomes × 400.

Stigonema panniforme. *Kirch. Alg. Schl.* 230.

Forming a thin tomentose stratum, more or less expanded, dark brown, trichomes ascending, very much branched, variously curved, branches unilateral, here and there fasciculate, often abbreviated, rounded at the apex, internal cells pale blue green, granulose, globose then compressed, arranged in a single, rarely in a double series, sheaths narrow, brown or yellow brown, paler at the tips or almost colourless.

SIZE. Trichomes ·035-·05 mm.

Eng. Fl. v., 363. Hass. Alg. 229, t. 66, f. 4, 5. Harv. Man. 153.

Sirosiphon panniformis, Kutz. Tab. Phyc. ii., t. 36, f. 2.

Scytonema panniforme, Ag. Syst. p. 39.

On rocks, stones, &c.

Plate CX. fig. 4. Portion of trichomes × 400 diam.

Stigonema mamillosum. (*Ag.*) *Kutz. Tab. Phyc.* II., *t.* 37, *f.* 4.

Forming continuous tufts several inches in diameter, branches simple, their diameter being greatest in the middle, and beset on all sides with mamillæ of various sizes.

SIZE. Trichome ·06-·1 mm., very variable.

Kirch. Alg. Schl. 229. Rabh. Alg. Eur. ii., 291. Eng. Fl. v., 363. Hass. Alg. 228, t. 66, f. 2, 3. Harv. Man. 153. Mack. Hib. 236.

Rocky bottoms of sub-alpine rivulets.

Plate CXI. fig. 3. Portion of young trichome × 400, becoming more opaque with age.

Stigonema compactum. *Kirch. Alg. Schl.* 230.

Forming an expanded compact tomentose dark brown stratum, trichomes and branches ascending, a little attenuated at the apices, obtuse, internally formed of a single, rarely a double series of cells, which are torulose and almost moniliform, diameter and length nearly equal, filled with a pale blue-green granular plasma, sheaths firm, golden brown, heterocysts sub-globose or oblong.

SIZE. Trichomes ·015-·016 mm.

Sirosiphon compactus, Kutz. Tab. Phyc. ii., t. 36, f. 3. Rabh. Alg. Eur. ii., 287. Leight. Lich. Flora, p. 9.

Hassallia compacta, Hass. Alg. 232, t. 68, f. 3.

Scytonema compactum, Eng. Fl. v., 365. Harv. Man. 154. Grev. Ed. 302.

On wet rocks.

Plate CXI. fig. 4. Portions of trichomes × 400 diam.

Stigonema turfaceum. (*Berk. Eng. Bot. Supp. t.* 2826, *f.* 1.)

Pulvinate, deep olivaceous black, 2 lines thick. Trichomes very thick, much branched, golden yellow, becoming brownish, variously curved, branches polymorphous, varying in thickness according to age, obtusely rounded at the apex, cells in several series, from 2 to 4 rows in the ramuli, sheaths thick, yellow brown, hyaline.

SIZE. Trichomes ·025-·03 mm.

Sirosiphon pulvinatus, Breb. in Kutz. Spec. 317 (1849). Rabh. Alg. Eur. ii., 290.

Hassallia turfosa, Hass. Alg. p. 232 (1845). Kutz. Sp. p. 318.

Scytonema turfaceum, Eng. Bot. ii., t. 2517, f. 1.

Dematium turfaceum, Link. Spec. i., 134.

On the ground in heathy places and on rocks.

Berkeley says that this Alga was named by Klotsch as *Dematium turfaceum*, Link., " which there is every reason to believe is correct." " It is," he says, " a true *Scytonema*." As far as we have been enabled to trace it, it seems to be the same as the *Sirosiphon pulvinatus* of Brebisson. The specific name of *turfaceum* has undoubted priority.

Plate CXI. fig. 2. Portions of trichomes × 400 diam.

Stigonema saxicolum. (*Naeg. in Kutz. Spec.* 316.)

Forming a thin dark olive velvety stratum. Trichomes minute, curved, variously branched, closely crowded into a thin dark crust or evenly scattered tufts ; sheath narrow, fuscous, cells in a single series, growing denser and nucleate with age.

SIZE. Trichomes ·018-·02 mm.

Sirosiphon saxicola (Nag.). Johnson in Grevillea xii., p. 76. Fischer Nost. fig. 13.

On damp rocks, or rocks down which water trickles.

Plate CXI. fig. 1. Abbreviated trichomes × 400, seldom exceeding this in size.

Stigonema minutum. *Hass. Alg.* 230, *t.* 67, *f.* 3, 4.

Spreading in a black suborbicular crust, or scattered in little tufts. Trichomes minute, erect, rigid, flexuous, fastigiate branches short, obtuse, sheath rather broad, fuscous ; cells usually in a single series.

SIZE. Trichomes ·02-·03 mm.

Scytonema minutum, Harv. Eng. Fl. v., 365. Harv. Man. 155. Mack. Hib. 236.

On moist rocks in Alpine districts.

Figured from the original specimen of the English Flora in the Kew Herbarium.

Plate CX. fig. 1. Portion of trichome, nearly complete, × 400 diam.

GENUS 112. **HAPALOSIPHON.** *Näg.* (1849.)

Trichomes formed mostly of a single row of cells, sheath slender. Aquatic plants, looking like *Tolypothrix*.

Hapalosiphon byssoideus. *Kirch. Alg. Schl.*, 231.

Tufts compact, dark olive, trichomes ascending, rigid, olivaceous, sparsely branched, containing cells arranged in a single series. Cells at first rounded quadrate, equal in length and breadth, becoming when older divided and shorter, one-third or one-fourth the length of their diameter ; sheath very thick, distinctly lamellose, golden yellow, attenuated and obtuse at the apex.

SIZE. Trichomes ·025-·03 mm. diam. Cells ·012 × ·01 mm.

Sirosiphon truncicola, Rabh. Alg. Eur. ii., 286. Hedwigia i., p. 47, t. ix., f. 3.

Hassallia byssoidea, Hass. Alg. 232, t. 67, f. 5.

Scytonema byssoideum, Harv. Eng. Fl. v., 366. Berk. Glean., t. 19, f. 1. Harv. Man. 156.

On trunks of beech, &c.

Plate CXI. fig. 5. Portions of trichomes × 400 diam.

SPECIES FOR ENQUIRY.

Dasygloia amorpha. *Thwaites.*

Gelatinous, amorphous, sheaths of the trichomes thick, mucilaginous, cohering, slightly branched ; internal trichomes blue-green, slender, simple, septate.

SIZE. Not indicated.

Dasygloia amorpha, Thwaites in Eng. Bot. ii. Supp., t. 2941.

In bogs.

Coalescing in a solid gelatinous mass, as large as a swan's egg. The filaments, quite at the base of the plant, have rather a membranous than gelatinous sheath, and closely resemble those of a *Lyngbya*, in consequence of which the base of the mass is green, but in the centre of the plant each filament is furnished with a very thick colourless gelatinous sheath, which is firmly coherent with those in contact with it. Towards the periphery of the plant these sheaths assume a brown colour, and become somewhat separate and distinct, rendering the surface shaggy. Occasionally the tips of the filaments are wound spirally round the portion beneath them.

Plate CXII. fig. 1. *a*, portion of gelatinous mass, natural size; *b*, threads, with gelatinous sheaths. magnified ; *c*, portion of trichome, without sheath, further magnified—all after Thwaites.

Petronema fruticulosum. *Thwaites.*

Plants densely cæspitose, erect, somewhat regularly branched, branches free, with obtuse rounded apices, and each with a heterocyst at the base. Endochrome annulated, increasing in diameter towards the apices of the filaments.

SIZE. Fronds ·2 mm. long, trichomes ·004 mm. diam.

Petronema fruticulosum, Thwaites, Eng. Bot. ii., Supp., t. 2959.

Scytonema crustaceum, Ag. Syst., p. 39 (*fide. spec. in Herb. Hook.*).

On rocks. Winter.

"Forms a frustulose areolated olive brown crust upon the wet perpendicular surface of limestone rocks, to which it adheres so slightly as to be very readily detached. The plants are densely crowded in little hemispherical masses, which, together, produce the peculiar areolated appearance of the crust. Each separate plant consists of a single filament at the base, which is from 1-4 or even more times tri- or tetracholomously branched, and thus a furticose habit is given to the species. Each branch has a connecting cell at its base, and sometimes one also at about the middle of its length. The very thick cartilaginous sheaths are of a pale brown colour towards the base of the plant but darker upwards, except at the apices, which are frequently nearly colourless. The endochrome is of a dull green colour, extremely narrow, and indistinctly annulated; towards the ends of the filaments, however, it becomes much wider and slightly moniliform."

There is in the Kew Herbarium (*Herb. Hookerianum*) a specimen of *Scytonema crustaceum*, Ag., received from that authority himself—the name written by him, which is clearly identical with Thwaites's plant, but it could not consistently be united either with *Scytonema* or *Stigonema*, hence we have retained the name applied to it by Thwaites and placed it here, subject to further investigation, its immediate allies being at present doubtful.

Plate CXII. fig. 2. *Petronema fruticulosum* after Thwaites; fig. 3, *Scytonema crustaceum* × 400, from authentic specimen received from Agardh.

SUB-TRIBE II. **TRICHOPHOREÆ.** *Filaments tapering at the top into a hyaline hair.*

FAMILY IV. CALOTRICHEÆ.

Filaments free, or agglutinated into a definite thallus, terminating at the apex in a delicate hair-like extremity. Heterocysts normally present, scattered, or basal.

GENUS 113. **CALOTHRIX.** *Ag.* (1824.)

Trichomes rather rigid, straight, attached, often fasciculate; growing in small tufts, or forming a turf of indefinite extent.

Calothrix Orsiniana. *Thur. Ann. Sci. Nat.*

Forming a pulvinate stratum, as much as two lines in thickness, dark brown, lubricous, opaque; trichomes elongated, branched, of nearly equal thickness, cuspidate at the apex or obtuse, distinctly articulate, here and there moniliform; sheaths thick, lamellose, golden brown, from the base to above the middle even, apical portion more or less dividing in fibrous lamellæ.

SIZE. Trichomes with sheath ·01-·012 mm., without sheath ·004-·006 mm.

Kirch. Alg. Schles., p. 219.

Scytonoma cirrhosum, Berk. Eng. Bot. ii., t. 2920.

Cænocoleus cirrhosus, Berk. Eng. Bot. ii., sub. t. 2940.

Schizosiphon cataractæ, Nag. in Kutz. Tab. Phyc. ii., t. 52, f. 1. Rab. Alg. Eur. ii., 235.

On rocks and submerged stones.

Although we have seen no authentic specimen of Berkeley's *Cænocoleus*, the specimens from Ben Lawers, which we have referred as above, appear to us to belong to the same species, as far as can be judged in the absence of all measurement.

Plate CXIII. fig. 1. Portion of trichome × 400; *b*, small fragment magnified with sheath from Eng. Bot. t. 2920; *c*, cells of trichome free from the sheath.

Calothrix Dillwyni. (*Hass. Alg.*)

Flaccid, bluish green or brown, trichomes usually cohering in pairs, sheaths inconspicuous, except towards the base, joints about half as long as their diameter, heterocysts at the base of the branches ovate or cordate.

SIZE. Trichomes ·005-·006 mm., with sheaths ·008-·01 mm.

Desmonema Dillwynii, Berk. Eng. Bot. ii., Supp., t. 2958.

Tolypothrix Dillwyni, Hass. Alg. 242, t. 68, f. 4-5.

Microcoleus Dillwyni, Harv. Man. 169.

Conferva vaginata, Dillw. Conf., t. 99.

On mosses and moist rocks.

Plant minute, flaccid, much branched, seldom a quarter of an inch in length, varying in colour from brown to bluish green. Filaments usually cohering in pairs. Sheaths inconspicuous, except those of the older filaments at the base of the plant, which become thickened and of a reddish brown colour. Endochrome annulated, more evidently so in the recently formed filaments than at the base of the plant, dotted from the presence of minute granules; joints about twice as broad as long, the terminal one somewhat dilated and hemispherical. The branches towards the base of the plant are seated each upon a connecting cell (heterocyst) of an ovate or cordate form. The plant possesses other branches formed by a dislocation of the endochrome, each separated portion becoming elongated, the lower portion towards the apex of the plant, and the upper portion towards the base, and each parallel and coherent with the other, and not usually separating until another dislocation has taken place in the endochrome of one of them, so that the filaments cohere mostly in pairs throughout the plant, though sometimes four or more filaments are coherent within one common sheath. The apparent branch (which is really a portion of the original filament) always extends beyond the filament from which it appears to be given off."

The dried specimens, which alone we have seen, are insufficient to determine the true relationship of this plant, hence, as well as the next, their position must be accepted as provisional.

Plate CXIII. fig. 2. *a*, natural size; *b*, portion enlarged; *c*, *d*, *e*, trichomes × 400 diam.; *c* and *d*, after Berkeley.

Species uncertain.

Calothrix (?) Smithii. (*Berk. in Eng. Bot.*)

Filaments red, creeping, branched, contained, with their ramifications, within a tough, more or less permanent sheath, which bursts irregularly, endochrome annulated, very slender, green, joints about as broad as long.

Size. Not stated.

Cœnocoleus Smithii, Berk. Eng. Bot. t. 2940.

On moors.

"Forming a red rugose mat of interlacing threads on boggy soil, where it is very conspicuous, but from which it is separated with difficulty on account of the roots and fibres of heath and moss to which it adheres.

"Threads elongated, branched laterally and acutely, their outer coat being cartilaginous, within which fresh branches are generated and creep within it till it is ruptured, when their free apices repeat the same phenomena. Occasionally some of the ramuli burst through the sheath at the base in pairs, as in genuine *Scytonemata*. Endochrome very slender, green, the articulations about as broad as long."—*M. J. B.*

Genus 114. **RIVULARIA.** *Roth.* (1824.)

Frond having a tendency to an hemisphærical or bladdery form. Filaments agglutinated by a more or less firm mucilage, exhibiting a disposition to radiate from the base of the frond. Frond usually with a well-defined outline. Heterocysts basal (placed at the base of the principal filaments and branchlets). Ramifications produced by the transverse division of the trichomes, the upper part of which detaches itself and becomes a lateral branchlet, while the lower part, extending itself by the side of the old tip, makes a new extremity similar to the first. Trichomes never producing any spores.

Rivularia echinata. (*English Botany.*)

Globose, very minute, dark coloured, compact. Threads fastigiate, attenuated upwards to the apex, closely cohering, articulated, heterocysts basal, globose. Sheaths very narrow, almost inconspicuous.

SIZE. Trichomes ·007 mm. at base, ·25 mm. long.

Chætophora punctiformis, Kutz. Tab. Phyc. iii., p. 4, t. 18, f. 2. Rabh. Alg. Eur. iii., 386.

Echinella articulata, Eng. Fl. v., p. 398. Eng. Bot. ii., t. 2555. Harv. Man. 187.

Conferva echinata, Eng. Bot. i., t. 1378.

Conferva echinulata, Gray. Arr. i., 310.

In lakes, ponds, &c.

This minute species, which was first described and figured in "English Botany," appears to have been unknown on the Continent. We have received it from several localities beside the original one of Ellesmere. It is one of the Algæ which are associated with the phenomenon called "Breaking of the meres," thus alluded to by Professor Dickie in his "Botanists' Guide" (p. 310) :—"For some years excursions were made with the students of my botanical class to a loch on the estate of Parkhill, about four miles north-west from Aberdeen. The sheet of water in question is about a quarter of a mile in its greatest length; on almost all sides it is surrounded by extensive deposits of peat, with the soluble matter of which a great proportion of the water passing into the loch is impregnated. The locality was generally visited in the beginning of July; nothing particular had ever been observed till the summer of 1846, when my attention was arrested by a peculiar appearance of the water, especially near the edge, but extending also some distance into the loch. Numerous minute bodies, with a spherical outline, and varying in size from 1-24th to 1-12th of an inch in diameter, were seen floating at different depths, and giving the water a peculiar appearance. In some places they were very densely congregated, especially in small creeks at the edge of the loch. A quantity was collected by filtration through a piece of cloth, and, on examination by the microscope, there could be no doubt that the production was of a vegetable nature, and a species of *Rivularia;* one, however, unknown to me, and not agreeing with the description of any species described in works to which I had access. Specimens were sent to the Rev. M. J. Berkeley; he informed me that the plant belonged to the genus mentioned, and stated it to be *Rivularia echinulata,* Eng. Bot. Along with it, but in very small quantity, I also found another plant, *Trichormus flos-aquæ*, Bory.

"In the first week of July, 1847, the same species were observed similarly associated, but the *Trichormus* was now more plentiful, without, however, any apparent corresponding diminution in the quantity of the *Rivularia*.

"In July, 1848, it was observed that the *Rivularia* was as rare as the *Trichormus* had been in 1846; to the latter consequently the water of the loch now owed its colour, which was a very dull green; the colour, however, becomes brighter when the plant is dried. In neither of the seasons mentioned was it in my power to make any observations on the colour of the loch earlier or later than the date above mentioned, consequently nothing can be added respecting the comparative development of the two plants at other periods of the season. Other two lochs in the vicinity did not contain the plants alluded to."

As these pages are being printed (July, 1884,) this alga has been sent us from a large pond between Haslemere and Farnham, rendering the water quite opaque, described as "like a mixture of pea soup and water." See also Bornet and Flahault, "Sur da determination des Rivulaires, &c.," in "Bulletin de la Societe Botanique de France," t. xxxi., p. 76 (1884).

Plate CXIV. fig. 2. *a*, natural size; *b*, cluster magnified; *c*, trichomes × 400 diam.

Rivularia calcarea. *Eng. Bot.* II. *ed.*, *t.* 1799.

Hemisphærical, gregarious, confluent in a very hard mamillose incrusting blue-green or brownish stratum, internally repeatedly zoned, zones of a darker green, trichomes rather thick, pale blue green, slightly flexuous, distinctly articulate, ending at the apex in a colourless hyaline point; sheaths narrow, colourless or brownish at the base; heterocysts globose, lower joints of the trichomes equal in length to their diameter.

SIZE. Trichomes ·006 mm. diam.

Eng. Fl. v., 392. Harv. Man. 150.

Ainactis calcarea, Kutz. Tab. Phyc. ii., t. 63, f. 11.

Lithonema calcarea, Hass. Alg. 265, t. 65, f. 2.

Zonotrichia calcarea, Rabh. Alg. Eur. ii., 213.

Linckia dura, *a calcarea*, Grev. Fl. Edin. 322.

On rocks and stones in streams.

Plate CXVI. fig. 3. *a*, section natural size; *b*, portion with trichomes × 400 diam.

Rivularia dura. *Kutz.*

About the size of a mustard seed, rather hard, dark bluish-green, becoming brownish or brackish; trichomes æruginous, variable in the same thallus, some thin and inarticulate, others thicker, articulate and torulose, all with distinct sheaths, lengthened at the apex into a colourless flexuous inarticulated thread; lower joints as long as broad, or nearly so, upper ones longer, all granulated; sheath colourless, or yellowish; heterocysts rounded, oblong.

SIZE. Trichomes ·008-·009 mm. diam. at the base.

Limnactis dura, Kutz. Tab. Phyc. ii., t. 64, f. 1. Rabh. Alg. Eur. ii., 211.

Rivularia radians, var. *dura*, Kirch. Alg. Schles. p. 223.

Attached to aquatic plants, especially *Chara*.

Plate CXV. fig. 2. *a*, natural size, *b*, section enlarged; *c*, trichomes × 400 diam.

Rivularia granulifera. *Carmichael MSS.*

Frond large, convex, becoming hollow underneath, fleshy, lubricous, brownish olive, often including strong particles.

SIZE. Trichomes ·006 mm. diam. at the base.

Harvey in Eng. Flor. v., 393. Harv. Man. 151. Hass. Alg. 363, t. 65, f. 1, 4.

On cliffs exposed to the trickling of water.

" Fronds from a line to half an inch in diameter, often confluent, convex, and at length concave underneath, fleshy, dusky olive-green, and extremely slippery. Filaments rather thick, repeatedly dichotomous." —*Carm.*

Plate CXV. fig. 1. Trichomes, from an original and authentic specimen, × 400 diam.

Uncertain Species.

Rivularia botryoides. *Carmichael MSS.*

Fronds minute, aggregated, roundish, wrinkled, ferruginous, cartilaginous. Trichomes dichotomous.

SIZE. Not stated.

Harvey in Eng. Flor. v., 392. Harv. Man. 150.

In streamlets, attached to rocks and stones.

" Fronds about a line in diameter, hemisphærical, wrinkled and cartilaginous, scattered, or running together like a bunch of grapes. Trichomes cohering firmly, obscurely striated, dichotomous. Colour when fresh, black, on drying, darkly ferruginous."—*Carm.*

We have seen no specimen, and therefore can add nothing to the above description.

Rivularia crustacea. *Carmichael MSS.*

Crust very thin, widely spreading, filaments attenuated at the base, fastigiately branched above the middle, olive green.

Harvey, Eng. Flora v., 393. Harv. Man. 151.

Lithonema crustaceum, Hass. Alg. 266, t. 65, f. 3.

On rocks exposed to the spray of cascades.

" Crust of no determinate extent, extremely, thin and slimy, black. Filaments one-fourth of a line in length, attenuated at the base, fastigiately branched above the middle, of an olive-green colour."—*Carm.*

GENUS 115. **ISACTIS.** *Thur.* (1875.)

Similar to *Rivularia*, from which it differs in the frond being flattened, and in the filaments being erect and parallel, and not radiating.

Isactis plana. *Thur. Notes Alg.* II., *p.* 165.

Frond crustaceous, plane, suborbicular or confluent, from 1 in. to 2 feet, dull green, darker in the centre, lubricous, gelatinous. Trichomes erect, parallel, sheaths hyaline.

SIZE. Trichomes ·008 mm. diam.

Born. and Thur. Notes Algol. ii., p. 165, t. 40, figs. 1-4.
Rivularia plana, Harv. Man. 152.
Dasyactis plana, Kutz. Tab. Phyc. ii., t. 73, f. 1.
Mastigonema plana, Rab. Alg. Eur. ii., 226.

Parasitic on *Enteromorpha* and other Algæ, chiefly in salt or brackish water, or on rocks by the sea.

Chiefly marine, but rarely on *Enteromorpha*, in estuaries and brackish ditches.

Plate CXIV. fig. 1. Trichomes × 350 diam.—after Bornet and Thuret.

GENUS 116. **GLOIOTRICHIA.** *Ag.* (1842.)

Trichomes pseudo-ramose, distinctly vaginate, sheaths broad, often saccate at the base, transversely plicate. Spores originating in the lower part of the trichome.

Gloiotrichia natans. *Thur. Ann. Sci. Nat.* 175, 377.

Globose or angular, tuberculose, variable in size and form, green, becoming brownish, trichomes straight, torulose, flexuous and hyaline above; lower joints more or less compressed. Sheath broad, here and there constricted, colourless or yellowish. Spores oblong, cylindrical, heterocysts subglobose.

SIZE. Trichomes ·01·-12 mm. at base, with sheath; ·03 mm. diam. Spores ·018 mm., and upwards, diam., several times as long.

Rivularia gigantea, Fischer Nost., fig. 6.
Rivularia angulosa, Kutz. Tab. Phyc. ii., t. 67, f. 2. Eng. Bot. t. 2551. Hass. Alg. 264, t. 60, f. 1-4. Eng. Fl. v., 394. Harv. Man. 153.
Gloiotrichia angulosa, J. Ag. Alg. Med. 8. Rabh. Alg. Eur. i., 201. Jenner, Tunb. Wells, 190.
Gloiotrichia Boryana, Kutz. Tab. Phyc. ii., t. 68, f. 2. Rabh. Alg. Eur. i., 201. Ralfs. Alg. Exs., 21.
Gloiotrichia gigantea, Rabh. Alg. Eur. ii., 201.
Rivularia pruniformis, Purt. Midl. Fl. ii., 617.
Rivularia natans, Gray Arr. i., 285.
Tremella utriculata, Huds. Ang. 564.

In ditches, ponds, &c.

Plate CXVI. fig. 1. Trichomes × 400 diam. *a*, homogones of same × 400 diam.

Gloiotrichia pisum. *Thur. Ann. des Sci. Nat.* 1875, 377.

Of the size and form of a pea, sometimes as large as a cherry, soft, even, or a little warted, dark olive-green, or brownish, trichomes elongated; the lower part blue-green, distinctly articulated, the upper part setiform, colourless, and indistinctly articulated, lower joints about equal in length and breadth, here and there somewhat swollen; heterocysts globose or subglobose.

SIZE. Trichomes ·01-·012 mm. diam. at base. Spores ·01-·012 mm. diam., of variable length.

Kirch. Alg. Schles. 222.

Rivularia pisum, Ag. Syst., p. 25. Rabh. Alg. Eur. i. 206. Berk. Glean. t. 11, f. 2. Eng. Fl. v., 392. Harv. Man. 150. Mack. Hib. 235.

Linkia dura, Grev. Fl. Ed. 322. Johnst. Fl. Berw. ii., 261.

Physactis pisum, Kntz. Tab. Phyc. ii., t. 60, f. 3.

In ponds, ditches, &c., adhering to aquatic plants.

Plate XCVI. fig. 2. *a*, plants natural size; *b*, trichomes of the same × 400 diam.

CLASS III. RHODOPHYCEÆ (or FLORIDEÆ).

Multicellular Algæ, with terminal vegetation. Thallus composed of a series of cells, either singly or disposed in strata, which are naked or corticate, of variable form, membranaceous, crustaceous, filamentose, vertically branched, fasciculate, foliaceous, &c. Cell contents for the most part reddish, rarely otherwise coloured. Reproductive organs of three kinds, very often disposed in different plants, viz. (1) Male organs, or antheridia; (2), Female organs, or cystocarps; and (3), Tetrasporangia.

For the most part marine.

FAMILY I. PORPHYRACEÆ.

Thallus mucous-membranaceous, foliaceous or filamentose, formed from a single stratum of cells, chiefly purplish. Vegetation by division of cells in two or more directions. Propagation by tetraspores.

GENUS 117. **BANGIA.** *Lyngb.* (1819.)

Thallus filamentous, terete or flattened, nearly plane, simple or branched, for the most part purplish, lubricose, formed from a single series of cells. Cell membrane thick, colourless, sometimes lamellose. Multiplication by the repeated division of the cell-contents in all directions.

Bangia atro-purpurea. (*Dillw.*) *Ag. Syst. p.* 76.

Forming lax purple tufts; threads abbreviated, scarcely exceeding an inch long, simple, varying in thickness according to age, joints nearly equal in length to their diameter, or one-third as long, more or less constricted at the joints.

Size. Filaments ·03-·06 mm. diam. Cells ·01 mm. long.

Rabh. Alg. Eur. i., 398. Eng. Bot. ii., t. 2413.
Conferva atro-purpurea, Dillw. Conf., t. 103. Eng. Bot. i., t. 2085.
Girardia fusco-purpurea, β. Gray Arr. i., 287.

Attached to wood and stones in streams.

In his most recent work Agardh advocates the removal of this genus to the *Ulvaceæ,* on account of the absence of genuine tetraspores.

Plate CXVII. fig. 1. *a,* portion of tuft, natural size; *b,* portions of threads × 400 diam.

Family II. CHANTRANSIACEÆ.

Forming dwarf pulvinate tufts, of a purplish-violet or steel-blue colour. Thallus filamentous. Threads articulate, formed of a single series of cells, branched, straight, naked, fasciculately branched above, joints cylindrical. Propagation by immovable spores formed at the tips of the branchlets. Tetraspores rarely observed.

Genus 118. CHANTRANSIA. *Fries.* (1825.)

The only genus in the family, with the same characters as given above.

Chantransia violacea. *Kutz. Tab. Phyc.* v. *t.* 44, *f.* 2.

Tufts bright violet, scarcely exceeding a line broad, pulvinately rounded, threads straight, branches becoming erect, radiately disposed; joints 3-6 times as long as broad, the apical joints rather obtuse.

Size. Cells ·008-·009 mm. diam.

Rabh. Alg. Eur. iii., 402. Kirch. Alg. Schles. 47.
Parasitic on *Lemanea, Cladophora,* and aquatic mosses.

Plate CXVIII. fig. 1. *a,* tuft natural size; *b,* portions of filaments × 300 diam.

Chantransia Hermanni. (*Roth.*) *Kutz. Phyc. Germ.* 230.

Cæspitose, pale rosy-purple, three lines long ; threads and branches whip-like, straight, branchlets spreading, then ascending, joints 3-6 times as long as broad, the final joints cuspidate, or rarely piliferous.

SIZE. Cells ·009-·002 mm. diam.

Ralfs. Ann. Nat. Hist. 1851, p. 403. Rabh. Alg. Eur. iii., 402. Kirch. Alg. Schles. 46. Kutz. Tab. Phyc. v., 43, f. 2.

Trentepohlia pulchella (Ag.) Eng. Fl. v., 382. Eng. Bot. ii., t. 2533. Harv. Man. p. 118. Johnst. Fl. Berw. ii., 242. Mack. Hib. 219.

Conferva nana, Dillw. Conf. t. 30. Gray Arr. i., 308. Eng. Bot. i., t. 2585.

On aquatic plants in streams.

" The tufts are dense, soft, and woolly, not gelatinous, and adhere but imperfectly to paper; they are often confluent, their colour is reddish, becoming tawny by age, and in drying. Filaments much branched, main branches elongated, somewhat level-topped, fructiferous branches lateral, numerous, short, patent, much divided. Capsules at first oval or clavate, finally orbicular, crowded in a corymbose manner, mostly stalked. Joints of stem 3-5 times as long as broad, those of fertile branches shorter. Differs from *C. chalybea* in colour, and in its shorter joints and more patent ramuli."—*Ralfs.*

Plate CXVIII. fig. 2. Portion of filament × 300 diam.

Chantransia chalybea. (*Lyngb.*) *Kutz. Phyc. Gen.* 229.

Cæspitose, steel-blue, about an inch long. Threads radiately disposed, adpressed, branches straight, joints three to six times as long as broad, spores collected in a racemose manner on lateral branchlets.

SIZE. Cells ·01-·011 mm. diam.

Ralfs. Ann. Nat. Hist. 1851, p. 304. Brit. Algæ Exs. No. 11. Rabh. Alg. Eur. iii., 402.

Conferva chalybea, Dillw. Conf. t. 91.

Conferva corymbosa, Eng. Bot. i., t. 1666, f. 1.

Trentepohlia corymbifera, Eng. Bot. ii., t. 2534.

Trentepohlia pulchella, *β*, *chalybea*, Eng. Fl. v., 382. Harv. Man. 118. Mac. Hib. 219.

Trentepohlia chalybea, Johnst. Fl. Berw. ii., 243.

Ectocarpus chalybeus, Gray Arr. i., 322.

Trentepohlia pulchella, Hass. Alg. 73, t. 8, f. 2.

Rivulets, waterfalls, and on water-wheels.

" Plant laxly tufted, of an inky colour, more or less tinged with green. Branches rather distant, level-topped, erect, their joints 4-6 times longer than broad. Fertile branches short, appressed, their joints shorter and usually turgid. Capsules orbicular, corymbose."—*Ralfs.*

Plate CXIX. fig. 3. *a*, portion of tuft natural size ; *b*, portions of threads × 300.

Chantransia pygmæa. *Kutz. Phy. Gen.* 285.

Tufts rounded, about a line in diameter, dingy greenish, becoming reddish, violet, or steel-blue when dry ; threads proceeding from a common centre, branched upwards in a somewhat fasciculate manner, branches erect, parallel, rather adpressed ; joints 2-3 times as long as broad, apical joints obtuse ; fascicles lateral or terminal.

SIZE. Cells ·011-·014 mm. diam.

Rabh. Alg. Eur. iii., 403. Kirch. Alg. Schles. 47. Kutz. Tab. Phyc. v., t. 45, f. 2.

In streams and springs.

Plate CXIX. fig. 2. *a*, tufts natural size; *b*, portions of filaments × 300 diam.

Chantransia investiens. *Lenormand in Kutz. Sp.* 431.

Parasitic, rose-red, much branched, joints many times longer than broad, spores solitary or in pairs, lateral and terminal, clavate or obovate.

SIZE. Cells ·006 mm. diam.

Ralfs. Ann. Nat. Hist. 1851, p. 303. Ralfs. Brit. Alg. Exs. No. 12. Kutz. Tab. Phyc. v., t. 45, f. 4.

Batrachospermum rubrum, Hass. Alg. 113, t. 15, f. 2-3.

On *Batrachospermum moniliforme* and *B. atrum.*

"Plant bright red, at first appearing as a minute reddish stain, finally clothing the invested plant with a continuous downy covering. Filaments creeping and interlacing at base, and surrounding the plant on which it grows, much branched. Branches not attenuated, alternate, erect, elongated ; joints very long, often twelve times as long as broad, and filled with pink, slightly granular endochrome. Capsules clavate or obovate, alternate or opposite, sometimes, though rarely, opposite a branch ; the terminal ones are more orbicular."—*Ralfs.*

Plate CXIX. fig. 1. Portions of filaments × 300 diam.

Uncertain Species.

Chantransia scotica. *Kutz. Tab. Phyc.* v. *t.* 42.

Cæspitose, about an inch long, steel blue ; threads sparingly branched, branches rather elongated, and, as well as the branches, somewhat divergent ; joints 2-3 times as long as broad.

SIZE. Cells about ·009-·01 mm. diam.

Rabh. Alg. Eur. iii. 402.

On old immersed wood.

We have no knowledge of this species. The figure is reproduced from that of Kutzing.

Plate CXVII. fig. 2. Portion of thread × 300 diam. After Kutzing.

Chantransia compacta. *Ralfs. Ann. Nat. Hist.* 1851, *p.* 304.

Plant minute, hemispherical, inky-green, firm; filaments much branched, joints twice as long as broad, branches erecto-patent.

SIZE. Not stated.

On aquatic plants.

"It forms very minute hemispherical tufts or fronds of a dark colour, and very much resembles a Rivularia in appearance; the fronds are so firm as to require considerable pressure in order to separate the filaments for microscopic examination. Filaments comparatively stout, rigid, much branched at the base, horizontal and interlacing. Branches crowded, erecto-patent; joints about twice as long as broad, but the lower ones frequently shorter. Capsules orbicular, numerous, lateral, arising from all parts of the plant, and usually on short stalks. Differs from *C. chalybea* in its compact, firm habit; more crowded branches, shorter joints and more scattered capsules."—*Ralfs.*

Probably this is *C. pygmæa*, but we have seen no specimen.

FAMILY III.—BATRACHOSPERMEÆ.

Diœcious algæ. Thallus filamentous, articulate, branched, violet, or violet-purple or bluish-green, covered with mucous; primary filament and branches composed of a single central series of cells, and numerous external parallel continuous or interrupted secondary series; either furnished with globosely or subglobosely densely conglobate tufts, of equally distant verticillate fascicles of branches, or everywhere densely covered with simple or forked branches. Vegetation terminal.

GENUS. 119. **BATRACHOSPERMUM.** *Roth.* (1800.)

Thallus moniliform, composed of a simple series of medullary cells, and a cortical accessory parallel series, clothed with subglobosely clustered fascicles of branches, which latter are sometimes more or less dispersed.

Professor Horatio Wood has abstracted so well what is known of the reproductive process in the Batrachosperms that we cannot do better than quote his observations in full: "Frequently in well-advanced Batrachosperms there will be seen scattered among the glomerules large round, firm, dense balls, composed of a great number of small closely attached cells. These are the reproductive bodies. According to Graf zu Solms Laubach ("Botanische Zeitung," 1867, p. 161), they are the result of sexual reproduction, and are developed from 'antheridia' and 'trichogonia' (female organs) in the following manner:—

"The antheridia are small roundish cells full of a colourless protoplasm, which is remarkable for the very numerous bright granules which it contains. They occur either scattered, or in groups, and are placed upon the upper ends of peculiar ovate cells, also filled with a colourless protoplasm. Most frequently there is a single antheridium to the basal cell, sometimes two; the latter number appears never to be exceeded. When matured the antheridia open, and allow their contents to escape in the form of roundish or flattened bodies, which never, as far as known, acquire cilia, and have, therefore, no power of spontaneous motion. These bodies, which are believed to be *spermatozoids*, are unprovided with anything like an external membrane, and are composed of protoplasm identical with that in the antheridium. While these changes are occurring, certain cells in other localities are being transformed into female organs, to which the name of *Trichogonia* is applied. These are borne upon cells similar to those supporting the antheridia. At first they are not markedly different from the other cells, but soon undergo a very rapid growth. This is not, however, regular, and is not partaken of by a band of tissue about one-third way from the basal end, so that at last a long somewhat flask-shaped cell is produced, with a very marked contraction at the point indicated, separating it into two portions. The wall of this cell is thin, but very distinct, and the cavity is filled with a homogeneous or very sparsely granular protoplasm, which is continuous through the narrow neck-like portion. After a time there appear one or more large irregular vacuoles, with actively moving corpuscles in them, and at the same time the neck appears to be stopped with a slimy substance. Careful examination with reagents shows that this is a cellulose, and that it does not completely block the passage way through the isthmus. At this time there appear lying upon the free end of the trichogonia globular or flattened bodies, without external membrane, corresponding in all respects with those already described as being produced in the antheridia. The end of the trichogonium generally enlarges at this period into a sort of roundish knob, and by and bye the end wall between this and one of these globules becomes absorbed, so that there is a free communication between the two. Whilst this is going on the globule acquires a thin delicate coat, and there appears in it a vacuole similar to those pre-existing in the trichogonium.

"The first result of this impregnation of the trichogonium is the deposit of new cellulose, and the complete blocking up of the passage way through the isthmus or narrowed portion. Already before the fecundation the upper cells of the branches supporting the trichogonia have produced numerous branchlets, which, growing upwards, more or less completely cover that organ. After impregnation the cells near to the trichogonium become much larger and broader, their vacuoles disappear, and are replaced by a dense granular dark greenish-brown protoplasm.

These cells now show a great activity in the production of numerous branches in the usual way; but it is the upper two alone which, with the trichogonium that they support, are concerned in the formation of the fruit glomerules. These put out all over their surface an immense number of protrusions, which soon, in the ordinary way, become the parents of as many twigs or branchlets, which, growing and branching precisely as do the vegetative branches, soon become excessively crowded. The base of the trichogonium participates also in the production of branches, and at last a dense ball is formed of pseudo-parenchymatous tissue by the forced adhesion of the crowded twigs. The central cells of the glomerule thus formed are very large and bladder-like. The outer part of the ball is composed of innumerable radiating rows of small cells, the end cell of each branch being roundish so as to present a convex external face.

"At maturity these cells open and allow their contents to escape as round masses, which appear to have no membrane, but begin at once to grow and secrete cellulose. Their after history has not been made out with absolute certainty, but they are believed to directly develop the new plant."—*Wood's Fresh Water Algæ of U.S.*, p. 218.

It is somewhat uncertain what should constitute the limits of species in this genus, so that, with the exception of *B. atrum*, we have not departed from the most generally accepted series, although we fail to distinguish more decided specific characters to separate *B. vagum* from *B. moniliforme* than can be found between, so-called, *varieties* of these species.

Batrachospermum moniliforme. *Roth. Cat. Bot.* III., 160.

From one inch to a foot in length, clothed with a more or less firm gelatinous mucous, violet-brownish, reddish-brown, purple, or bluish-green, vaguely and profusely branched, joints of the branches similar, oblong or clavate, outer ones sometimes setigerous, internodes naked, or furnished with scattered accessory branches.

Size. Cellules ·02-·022 × ·01 mm.

Rabh. Alg. Eur. iii., 405. Kirch. Alg. Schles. 45. Eng. Fl. v. 388. Jenner, Tunb. Wells, 176. Eng. Bot. ii., t. 2542. Harv. Man. 119. Johnst. Fl. Berw. ii., 257. Mack. Hib. 221. Hass. Alg. p. 109. Hook. Fl. Scot. ii., 77. Gray Arr. i., 330. Vauch. Conf. 112, t. 1, f. 5; t. xi, f. 4.

Conferva gelatinosa, Dillw. Conf. t. 32. Relh. Cant. Supp. 21. Hull Br. Fl. 332. Eng. Bot. i., t. 689. Huds. Ang. ii., 597. With. Arr. iv., 134. Lightf. Fl. Scot. 986. Sibth. Ox. 337. Abbot. Bedf. 275.

Conferva fontana nodosa spermatis ranarum, Ray Syn. 62. Dill. Musc. 36, t. 7, f. 42-46.

Batrachosperma ludibunda moniliformia, Bory. Ann. des Mus. xx., t. 30, f. 1.

In streams and ditches.

Plate CXX. fig. a, portion of filament × 30 diam.; *b*, portion × 200 diam.

var. **setigerum.** *Rabh. Algæ Exs. No.* 854.

The extremities of the moniliform branchlets attenuated into a long setiform thread.

Size. Cells ·02 -·024 × ·01 mm.

var. **pulcherrimum.** *Bory. Ann. des. Mus. p.* 40.

About four inches long, violet or purple, the gelatinous investment less developed. Branches elongated, whorls rather distant, globose, with the apices of the branchlets almost confluent, interstitial spaces nearly naked.

Size. Cellules ·018 × ·01-·012 mm.

Kirch. Alg. Schles, 45. Rabh. Alg. Eur. iii., 405.

Batrachospermum pulcherrimum, Hass. Alg. 109, t. 14, f. 1.

Batrachosperma ludibunda pulcherrima, Bory. loc. cit.

"The extreme elegance of form and of colour renders this *Batrachospermum* remarkable; its stems are rather more branched than those of the variety *confusum*, and less than those of *B. moniliforme*, are from 2 to 3½ inches long, slender, and of an intermediate diameter. The globules are perfectly sphærical, distant upon the stems from each other the length of a ray, more approximate, flattened, but always distinct in the branches. Its colour is a clear grey, approaching to a most agreeable violet; this last tint becomes dominant in drying, and passes sometimes to red."—*Hassall.*

Plate CXXI. fig. a, portion of filament × 30; fig. *b*, smaller portion × 200.

var. **proliferum.** *Kutz.*

Stem and primary branches densely set with short accessory branchlets.

SIZE. Cellules ·018 × ·01 mm. diam.

Rabh. Alg. Eur. iii., 406.

Batrachospermum proliferum, Hass. Alg. 112, t. 63, f. 1.

B. moniliforme, *β proliferum*, Carm. MSS.

"Frond solitary, or in small clusters, 1 or 2 inches long, irregularly branched, branches divaricate, curved, or flexuous, opaque, and very dark coloured, beset with short ramuli, which issue out from the joints among the whorls, of eccentric filaments, and are themselves beset with whorls. Colour grey.—*Carmichael.*

Plate CXXII. Portion of filament × 200 diam., from original specimen.

var. **confusum.** *Hass. Alg.* 105, *t.* 15, *f.* 1.

For the most part bright violet, 2-3-4 inches long, and similarly expanded, densely involved in a gelatinous mucous, whorls approximate, with numerous interstitial ramuli irregularly disposed.

SIZE. Cellules ·02-·022 × ·01 mm.

Rabh. Alg. iii., 405. Kirchn. Alg. Schles, 45.

Batrachospermum confusum, Hass Alg. 105.

Batrachospermum giganteum, Kutz. Tab. Phyc. iii., t. 23.

Batrachosperma ludibunda confusa, Bory. Ann. des Mus. xx., t. 29, f. 3.

"Of all Batrachosperms this acquires the greatest dimensions. Its length is sometimes four inches and a half, its diameter equal often to that of the culms of grasses. Its branches appear also to be less obtuse than in the other varieties. The globules, or whorls, are so approximated and so large that they are often confounded together in such a manner as to be with difficulty distinguished in certain specimens which have the aspect of *B. helmintosum*. The colour of the plant is of a mouse-grey, agreeable by its transparency. The large stems approach a little upon yellow. These tints become of a beautiful violet by putrefaction. It is upon individuals of this variety that I made for the first time, twelve years ago, an experiment which ought to be known; after having many times carried from one locality to another stones bearing individuals of this species, which continued to prosper in spite of the change of habitation, I steeped many of them in lukewarm water, afterwards in boiling, and no part of the *Batrachosperm* appeared, under the microscope, to have undergone the slightest disorganization by these immersions, and certain sprigs, replaced in their native place, continued to vegetate after these experiments. I do not think that there exist other vegetables which boiling water does not immediately disorganize, there are not others that can resist temperatures so opposite."—*Bory.*

Plate CXXIII. Portion of filament × 200 diam.

var. **Bòltoni.** *Cooke.*

This variety differs in the large size and very globose form of the joints of the whorls. The apices are very often setiform.

SIZE. Cellules ·025 × ·02, or ·022 × ·018 mm.

This variety, found by Mr Thomas Bolton, of Birmingham, seems to differ sufficiently to be worthy of notice as a distinct variety. In colour it was a beautiful green, with a tendency to pass into blue in drying.

Plate CXXIV. Portions of a filament × 200 diam.

var. **stagnale.** *Ag.*

One or two inches long, blue or steel-blue. Whorls of the stem confluent, of the branches distant.

Rabh. Alg. Eur. iii., 406.

Batrachosperma ludibunda stagnalis, Bory. Ann. Mus. xx., p. 42.

Batrachospermum stagnale, Hass. Alg. p 107.

Conferva fontana nodosa, &c., Dill. Musc. f. 44.

"This variety has great resemblance in form and diameter to *confusum;* it is nevertheless shorter, but as thick. Its whorls are round and distinct; they are more approximated the one to the other in the large stems, about which they are sometimes even confused. Their colour is a greenish-yellow, pale and livid."—*Hassall.*

var. **alpestre.** *Shuttleworth.*

Frond black, very mucous, much branched, alternately forming very obtuse angles with the principal filaments. Whorls of the stem sphærical, distinct, but approximate, branches compressed.

Batrachospermum alpestre, Hass. Alg. 111, t. 14, f. 2.

"This species is easily recognized by the eye alone, either in its recent or dried state; in the former its size, great lubricity, jetty black colour, and approximate, yet for the most part, exactly sphærical whorls, are remarkable; in the latter, in which also the black tint is preserved, it may be distinguished by the multiplicity of its branches, which are, except the primary ones, exceedingly short and irregular, and issue from the main filaments almost at right angles, and by their non-moniliform appearance. In drying, also, it shrinks considerably."—*Hassall.*

var. **helmintosum.** *Bory Ann. d. Mus. t.* 29, *f.* 2.

Filaments branched, pyramidal, naked below, branches simple, subpinnate, acute whorls contiguous, compressed.

Batrachosperma helmintosa, Bory Ann. Mus. xx. p. 33.

Batrachospermum helmintosum, Hass. Alg. p. 105.

"The stems of this beautiful species scarcely exceed 2 inches in length. They are fine, and denuded at their base, which appears yellow. Numerous branches proceed from it; they are somewhat subulate, and diminish in length in such a way that they incline from the extremities of the plant, and give it a pyramidal appearance. The whorls are compressed, voluminous, horizontal, and so approximated that they cannot acquire the globular form; they become confused, and form round the stems a continuous cylinder of mucosity. The diameter of this cylinder equals often that of the plume of a little bird. The branches are not less thick at their insertion. The colour of the plant is obscure, of a bluish and uncertain green."—*Bory.*

var. **bambusinum.** *Bory. Ann. d. Mus. t.* 29, *f.* 1.

Filaments sparingly branched, branches simple, cells much elongated, whorls minute, distant.

Batrachosperma bambusina, Bory Ann. Mus. xx. p. 32.

Batrachospermum bombusinum (Bory). Hass. Alg. 103, t. 13, f. 3.

"Its colour is of the most elegant green; but if the specimens be not quickly prepared they very soon turn black upon the paper. From a principal filament, 2-4 inches long, proceed many long, slender, loose branches, simple, or having sometimes here and there scattered, very small branches, which are never divided. The articulations of the principal stem, and of the larger branches, are for the most part naked; their point of contact is dilated in such a manner as to resemble the rods of bamboos. As to the whorls, they are rounded, smaller than those of the neighbouring species, composed of very compact branchlets. Their simple ramuli are likewise shorter than in the other Batrachosperms; three or four rounded joints compose them; the ciliform appendage which terminates them is remarkable. Some ramuli, shorter than those of the whorl, cover also the inferior part of the articulations, which have the appearance of reversed cones."—*Bory.*

Batrachospermum vagum. (*Roth.*) *Ag. Syst.* 52.

Vaguely branched, 1-3 inches long, brownish or bluish-green; inferior internodes covered with a dense mass of branchlets, the superior naked, or nearly so, apical joints of the branchlets attenuated into a long bristle.

Size. Cellules ·025 × ·012 mm.

Rabh. Alg. Eur. iii., 406. Kirch. Alg. Schles. 46. Eng. Fl. v., 388. Eng. Bot. ii., 197. Harv. Man. 119. Hass. Alg. 109, t. 63, f. 2. Kutz. Spec. 536.

Batrachosperma turfosa, Bory Ann. des Mus. xx., t. 32, f. 1.

"In no other *Conferva* is the number of the filaments so considerable as this. Their total diameter equals that of the largest horsehair. They divide in every direction from a little disc, ramify to infinity, observing remarkably well the dichotomous disposition in their first division, their branches becoming subsequently vague. Their total length extends even to four inches.

"From their origin even to their extremity these filaments are clothed with microscopic branches, so impacted that the whorls are not apparent in scarcely any direction; with a simple lens they are not better discovered, from which it might be supposed that one was observing a *Thorea*. It is but towards the points of the branches that, by the assistance of a strong lens, they are at last distinguished. These whorls are very closely approximated, horizontal, compressed the one upon the other, and becoming so confused as to form around the filament, which is green or yellow, and very flexible, a continuous down, mucous to the touch, sometimes very pale, more frequently of a very agreeable bluish watery green; this colour is, moreover, deep towards the point of the branches. As it grows old the plant turns yellow, and is discoloured."—*Bory.*

var. **keratophytum.** *Bory.*

Beautiful blue-green, thin, very much branched, dichotomous, with the black setaceous base naked, branches all equal, slender, thin, apex slightly incrassated, whorls distinct.

SIZE. Cellules clavate, about ·03 × ·015 mm.

Batrachosperma keratophyta, Bory Ann. Mus. xx., t. 31, f. 2.

Batrachospermum suevorum, Kutz. Spec. 536.

Habit, colour, and ramification of *B. vagum*, but with the whorls distinct.

Plate CXXV. fig. a, portion of filament × 30; *b*, portion × 200 diam.

Batrachospermum atrum. *Harv. Man.* 119.

Violet-coloured when moist, dark brown, almost black when dry, vaguely and much branched, reaching 2 inches, whorls abbreviated, distant; interstitial branchlets very short, one or two-celled.

SIZE. Cellules ·012 mm. diam.

Jenner Tunb. Wells 176. Hass. Alg. 114, t. 16, f. 4.

Conferva atra, Dillw. Conf. t. 11. Hull Br. Fl. 332. Huds. Ang. ii., 597. Eng. Bot. i., t. 690. With. Arr. iv., 134. Gray. Arr. i., 330.

Batrachospermum detersum, Eng. Bot. ii., t. 2543.

Batrachospermum moniliforme, v. *detersum*, Eng. Fl. v., 388. Mack. Hib. 221.

Batrachospermum moniliforme, var. i. *atrum*, Rabh. Alg. Eur. iii., 406. Kirch. Alg. Schles. 45.

Lemanea setacea, Bory Ann. de Mus. t. 23, f. 3.

In streams and ditches.

Plate CXXVI. fig. 1. *a*, portion of filament × 30; *b*, portion × 200 diam.

"The articulations, or internodes, may be compared to reversed cones, the superior part or whorls being formed of a few short, simple subulate filaments, which are not beaded; in these filaments the colouring matter chiefly resides, and it is amongst them that the glomerules are formed; that portion of each articulation which is below the whorl is transparent, and beautifully exhibits the tubular and jointed structure of the layers which invest the primary cells in all the species of the genus *Batrachospermum*; from many of these tubes short branches are given off, which have almost the appearance of scales."—*Hassall.*

var. **Dillenii.** *Bory. Ann. de Mus.* xx., *t.* 22, *f.* 2.

Filaments dark brown, very thin, lower nodes remote, the interstices beset very densely with prominent cells, upper nodes crowded, branchlets very short, consisting of 3-4 cellules, extreme apical nodes confluent.

SIZE. Cellules ·012 mm. diam.

Lemanea Dillenii, Bory. Ann. de Mus. xx., 23.

Batrachospermum vagum, e. *Dillenii*, Rabh. Alg. Eur. iii., 407.

Conferva fontana nodosa, lubrica, nigris, Dill. Musc. t. 2, f. 46.

This is usually considered as a variety of *B. vagum*, but it seems more closely allied to *B. atrum*, if that be really a distinct species.

Plate CXXVI. fig. 2. Portion of filament × 200 diam.

GENUS 120. **THOREA.** *Bory.* (1808.)

Thallus filamentose, attenuated at the apex, branched, purple-brown, villose, mucous, with a solid central medullary stratum, surrounded by dichotomously divided branchlets.—*Sur un genre nouveau de la Cryptogamie aquatique, nommé Thorea.*

Thorea ramosissima. *Bory Ann. Mus.* xx. 127.

From a hand's-breadth to a foot long, and rarely two feet, very much branched, about the thickness of a horsehair, dark-green, of a beautiful purple-violet when dry, ramelli spreading horizontally, long and short alternating, articulate; joints 1-3 times as long as broad, or twice that length.

Harv. Man. 120. Hass. Alg. 65, t. 16, f. 3-4. Rabh. Alg. Eur. iii.

Batrachospermum hispidum, De Cand. Fl. Fr. ii., 60.

Attached to wood, &c. Walton-on-Thames.

Plate CXXVII. fig. a. Small plant, natural size; *b*, ramuli and spore; *c*, portion of filament × 400.

Family IV. LEMANEACEÆ.

Fluviatile algæ. Thallus developed from a confervoid prothallic filament, setaceous, almost simple, hollow, nodose, having an internal and a cortical layer of cells. Polyspores numerous, collected in branched moniliform series, germinating without fertilization.

Genus 121. **LEMANEA.** *Bory.* (1808.)

The only genus in the family, with the same characters as above given.

"The dilated portions of the threads are loosely filled with the spores, which are produced within the frond. The spores are oval, thick-walled cells, joined together to form series. which are very much branched, so that from a central basal row they rise as a complex bush-like mass. The first step, according to Wartmann, in their germination, consists in the elongation of the spore, and the projection of one end, which is soon cut off by the formation of a transverse partition, and constitutes a new cell. This multiplication soon develops into a branched confervoid filament. A large number of these filaments are generally produced in one place at one time, and form a very apparent greenish layer. Finally, certain cells in branches of these filaments swell up and become very much broader than their fellows, undergoing, at the same time, division so rapidly that they become very short. By-and-bye they divide also in the direction of their breadth, so that, instead of a simple series of cells, there arises a compound mass. This is the beginning of the new frond. At first it is dependent upon the parent filament, but soon acquires a root-like process at the base, and develops rapidly into the complex cartilaginous plant."—*Wartmann, Beitrage zur Lemanea* (1854).

Lemanea fluviatilis. *Ag. Spec. Alg.* II. *p.* 4.

Simple, or sparingly branched, 3-4 inches long, straight, nodules rather remote, with about three verticillate papillæ.

Size. Spores ·04 × ·025 mm.

Rabh. Alg. Eur. iii., 411. Kirch. Alg. Schles. 43. Eng. Fl. v., p. 322. Hook. Fl. Scot. ii., 84. Eng. Bot. ii., t. 2423. Jenner Tunb. Wells 176. Harv. Man. 119. Johnst. Fl. Berw. ii., 246. Mack. Hib. 220. Gray Arr. i., 288. Hass. Alg. 72.

Lemanea corallina, Bory Ann. de Mus. xx., t. 21, f. 2.

Conferva fluviatilis, Dill. Conf. t. 29. Hull Br. Fl. 332. Eng. Bot. i., t. 1763. Huds. Ang. ii., 597. With. Arr. iv., 134. Lightf. Fl. Scot. 985.

Conferva fluviatilis lubrica setosa equiseti facie, Dill. Musc. 39, t. 7, f. 47.

Nodularia fluviatilis, Grev. Fl. Ed. 300. Fl. Devon. ii., 57.

Attached to stones, wood, &c., in streams.

" From a cartilaginous disc, strongly applied to foreign bodies, proceed a great number of close filaments, elastic, of a brownish-green colour, and a little curved at the base, but they become more pale and straight in the remainder of their length. These filaments are ordinarily from 4 to 7 inches in length. Some are entirely simple, the others throw out here and there branches, or divide towards the middle of their length. The internodes are oblong, from a line to a line and a half, cylindrical, and inflated at their points of contact. Their divisions are often but little apparent, and disappear towards the base of the filaments, which appear continuous, cylindrical, and equal in diameter to a strong horse-hair. The surface of the filaments in old age is encrusted in such a manner as not to become recognizable either by its colour, which changes, or by the destruction of the internodes, which become confused and disappear."—*Bory*.

Plate CXXVIII. fig. 1. Filaments natural size; *a*, portion of filament magnified; *b*. section of same; *c*, chains of spores × 200.

Lemanea torulosa. (*Roth.*) *Ag. Spec.* II. 4.

Nearly simple, for the most part bent like a bow, 1-2 inches long, nodules approximate, papillæ flattened, sometimes confluent or almost obsolete.

SIZE. Spores ·04-×·022-·03 mm.

Rabb. Alg. Eur. iii., 411. Kirch. Alg. Schles. 43. Eng. Fl. v., 322. Gray Arr. i., 288. Hass. Alg. 71, t. 7.

Conferva torulosa, Dillw. Conf. p. 77, t. F.

Conferva fluviatilis nodosa fucum emulans, Dill. Musc. t. 7, f. 48.

Lemanea fluviatilis, var. β. *torulosa*, Eng. Bot. ii., t. 2423. Harv. Mon. 119.

Conferva fluviatilis, var. 2. With. Arr. iv., 134.

In streams.

" From a little horny disc, fixed to the hard bodies which support it, arise from six to thirty filaments, from one inch to 2½ inches in length, curved in one direction. Their colour is of a brownish or reddish-green, obscure or livid. They acquire in diameter the greatest dimensions of all the Confervæ."—*Bory*.

Bory states that " M. Thore, of Dax, first remarked, in the *Conferva fluviatilis* of Linnæus, a fact which is verified in the other species of our genus. The recent filaments of this *Lemanea*, presented towards the flame of a candle, explode and extinguish the candle. This phenomenon does not take place in dried specimens. It is owing to some gas shut up in the connections of the joints, and which, put in expansion by the heat, presses against the walls and breaks them with an explosion. A remarkable movement of retraction is experienced in the fingers which hold by the two extremities the filament experimented upon. As to the smell of the burnt plant, although very peculiar, it cannot be compared to that of animal substances submitted to the fire. I have not met with any *Lemania* in stagnant waters; they grow in quick waters. It is in the pure fountains, large rivers, in very rapid rivulets, that they appear to delight. Many, moreover, flourish especially in those places where the current has the greatest force, such as in mill sluices, and the most impetuous falls of cascades."—*Hassall's Algæ*, p. 70.

Plate CXXVIII, fig. 2. Filaments natural size.

SUPPLEMENT.

To follow at page 4 —

Pleurococcus bituminosus. (*Bory. Dict.* III., 15.)

Thallus mucous, brown-black, or pitch-colour, cells small, rounded angular, greenish brown, 4-8 associated in families, tegument scarcely broad, colourless, hyaline, indistinctly lamellose.

SIZE. Cells ·002 mm.; families 0·1-·02 mm.

Rabh. Alg. Eur. i., 28.

Chaos bituminosus, Bory. Dict. iii., 15.

Palmella bituminosa, Meneg. Nost. p. 56.

Protococcus bituminosus, Kutz. Tab. Phyc. i., t. 5.

Gleocapsa bituminosa, Kutz. Spec. 224.

On walls of damp cellars, &c.

Plate CXXIX. fig. 1. Cells and families × 400 diam.

Pleurococcus vestitus. *Reinsch. Algen. Fl. p.* 56.

Cells solitary, rarely united in small families, orange; cell-membrane thick, densely invested with small hairs.

SIZE. Cells ·012-·022 mm. diam.

Rabh. Alg. Eur. i., 29.

Acanthococcus vestitus, Lagerh. Svenska Vet. Akad. Forh., 1883, p. 37.

Plate CXXIX. fig. 2. Cells × 400 diam.

GENUS 14 *bis*. **DACTYLOCOCCUS.** *Nag.* (1849).

Cells oblong or fusiform (at first ovate-cuspidate, then ellipsoid), free swimming, 2-8 associated in families, at length dividing and becoming single.

Propagation by division in one direction.

Dactylococcus De Baryanus. *Reinsch. Contrib. t.* x., *f.* 1.

Cells broadly elliptical-oval, apex broadly rounded, base attenuated into a hyaline pedicel, half as long as the cell, and expanded at its extremity, single or twin, cell-contents intense green, granulose, at length divided in 3 or 4. Cell membrane thick.

SIZE. Cells ·033 × ·016 mm.

Parasitic on small aquatic crustaceans, *Entomostraca*, &c.

Plate CXXIX. fig. 3. *a*, individuals × 400 diam.; *b*, two individuals × 720 diam.

To be inserted at page 91 —

Spirogyra velata. *Nordst. Lund. Univ. Arsskrift,* 1872, *Vol.* IX.

Sterile cells with the ends truncate, 3-4 times as long as broad, chlorophyll band single, making $1\frac{1}{2}$ to $2\frac{1}{2}$ turns in the spiral.

Spores elongated-oval, polymorphous, $1\frac{1}{2}$ to 3 times as long as broad; epispore thick, composed of four membranes; the second is hyaline and scrobiculate; the third is coloured (*Nordstedt*).

Sporiferous cells a little swollen or not at all, sometimes shorter, sometimes a little longer than the spores.

SIZE. Cells ·035-·04 mm.; zygospore ·06 × ·035—·085 × ·045 mm.

Petit Spirogyra, p. 25, t. 7, fig. 1-5.

In ditches.

England (Leicester. F. Bates).

The zygospore has a broad hyaline border finely denticulate with the scrobiculations of the second membrane.

Plate CXXX. fig. 1. *a*, sterile cells × 200; *b*, sterile cell × 400; *c*, fertile cells with zygospores × 200 diam.; *d*, *e*, *f*, zygospores with the investing cells × 400 diam.

At page 165, after *Œ. capillare*, add —

Œdogonium capilliforme. *Kutz. Spec.* 367 (?).

Oogonia single, a little swollen, obversely egg-shaped, opening with a superior pore; oospores ellipsoid-globose or cylindrically globose (almost four-angled in optical section), not filling the oogonia; male plants a little more slender than the females; spermogonia 2-10 celled, alternating with the vegetative cells; terminal cell obtuse.

SIZE. Cells of female ·03-·034 mm., $1\frac{1}{4}$ to 3 times as long; of male ·024-·028 mm., $1\frac{1}{2}$ times as long; oogonium ·042-·048 × ·051-·062 mm; oospore ·037-·045 × ·04-·05 mm., usually ·039-·04; sperm. cell ·02-·025 × ·008-·01 mm.

Wittr. Mon. Œdog. p. 31. Kutz. Tab. Phyc. iii., t. 37, f. 3 (?).

In pool and ditches.

Britain (Leicester. F. Bates).

Plate CXXIX, fig. 4. *a*, female filament with oogonia × 400 diam.; *b*, male cells with alternating spermogonia × 400 diam.

Insert at page 187 —

Chroolepus umbrinum. *Kutz.*

Stratum thin, crustaceous, rather pulverulent, reddish brown growing pale when dead, threads and branches abbreviated, torulose, joints nearly as long as broad, broadly elliptic or subglobose.

SIZE. Cells ·02 mm. diam.

Rabh. Alg. Eur. i., 372.

Protococcus crustaceus, Kutz. Spec. 203.

Protococcus umbrinus, Kutz. Phyc. Gen., t. 7, f. 2. Cohn in Hedwigia i., p. 1.

On the bark of beech and oak. (Kelvedon. E. G. V.)

Plate CXXX. fig. 2. *Chroolepus umbrinum* × 400 diam.

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GLOSSARY.

Achromatic (*a*, Gr. without, + *chromos*, colour).
Colourless.

Acicular (*acus*, L. a needle).
Needle-shaped.

Acuminate (*acumen*, L. a point).
Tapering to a point.

Æruginous (*ærugo*, L. rust of copper).
Of the colour of verdigris—blue green.

Agamo-hypnospores (*agamos*, Gr. unmarried, + hypnospores).
Neutrally formed resting spores.

Agamospore (*agamos*, Gr. unmarried, + spore).
Spore formed neutrally without fecundation.

Agamosporous (*agamos*, Gr. unmarried, + spore).
Bearing spores without fecundation.

Alternate (*alternus*, L. one after another).
Two organs so placed as not to be opposite to each other.

Amœboid (*amœba*, + *eidos*, resemblance).
Resembling an Amœba.

Amorphous (*a*, Gr. without, + *morphos*, form).
Without definite form.

Amylaceous (*amylon*, Gr. flour).
Resembling starch.

Anastomose (*anastŏmo*, Gr. to furnish with a mouth, to bring to a mouth).
The opening of one vessel into another, applied to threads or tubes which become confluent, and form an irregular network.

Androgonidia (*anēr*, Gr. a man, + gonidia).
Peculiar zoogonidia produced by female plants from which male plants are developed.

Androsporangium (*aner*, Gr. a man, + sporangium).
Sporangium enclosing spores of male plants, or androspores.

ANDROSPORE (*aner*, Gr. a man, + *spora*, a seed).
A special kind of zoospores produced in cells, which originate the dwarf males in *Œdogonium*.

ANTHERIDIA (anther, + *eidos*, resemblance).
Certain reproductive organs supposed to be analogous to anthers, or fecundative.

APICULUS (diminutive of *apex*, L. a short point).
Ending with a short point.

ARCUATE (*arcuo*, L. I bend like a bow).
Bent like a bow.

AREOLA (*areola*, L. a little space).
An angular space with an elevated margin.

ARTICULATE (*articulus*, L. a joint).
Composed of joints.

BILOBATE (*bis*, L. twice, + *lobus*, a lobe).
Having two lobes.

BINATE (*binus*, from *bis*, L. by couples).
In pairs.

BOTRYOID (*botrys*, Gr. a bunch of grapes).
Collected in clusters like a bunch of grapes.

BULLATE (*bulla*, L. a bubble).
Blistered or puckered.

CÆSPITOSE (*cæspes*, L. a turf or sod).
Growing in tufts, after the manner of a turf strictly, with many stems from one root.

CAPILLARY (*capillus*, L. a hair).
Thread-like, resembling a hair.

CARPOSPORE (*carpos*, a fruit, + *spora*, a seed).
Spores produced (by conjugation) in a sporo-carpium.

CARTILAGINOUS (*cartilago*, L. a tendon).
Hard and tough like cartilage.

CAULOID (*caulus* L. a stalk or stem).
Resembling, or analogous to, a stem.

CHLOROPHYLL (*chloros*, Gr. green, + *phyllon*, a leaf).
The green colouring matter of leaves, and other green parts of plants.

CHLOROPHYLLOSE (*chloros*, Gr. green, + *phyllon*, a leaf).
Resembling chlorophyll green.

CILIATE (*cilium*, L. an eyelash).
Furnished, or fringed, with hairs.

CILIUM, CILIA (*cilium*, L. an eyelash).
Hair or bristle placed marginally.

CIRCINATE (*circino*, L. I turn round).
Curled round, like the young frond of ferns.

CIRCUMSCISSILE (*circum*, L. around, + *scindu*, I cut).
Cut round transversely.

CLATHRATE (*clathrus*, L. a lattice).
Latticed, or perforated like a window.

Cœnobium (*coenobios*, Gr. a community of living).
A community of a definite number of individuals united in one body.

Concentrically (*concentricus*, L. with a common centre).
In rings, with a common centre.

Cordate (*cor*, L. the heart).
Heart-shaped.

Coriaceous (*corium*, L. leather).
Of a leathery consistence.

Corymbose (*corymbos*, Gr. the top, a cluster of fruit or flowers).
Resembling the inflorescence called a corymb.

Crenate (*crena*, L. a notch or cleft).
Notched or scalloped.

Crustaceous (*crusta*, L. the hard surface of a body, the rind).
Hard and brittle, or forming a crust.

Cuneate (*cuneus*, L. a wedge).
Shaped like a wedge.

Cuspidate (*cuspidatus*, L. pointed).
Tapering gradually to a sharp, stiff point.

Cytoblast (*cytos*, Gr. a cell, + *blastos*, a germ).
A cell germ.

Cytoderm, Cytioderm (*cytos*, Gr. a cell, + *dermos*, a membrane).
Cell membrane.

Cytoplasma, Cytioplasm (*cytos*, Gr. a cell, + *plasma*, formation).
Cell contents.

Decussate (*decussatus*, L. cut crossways like the number X, *decem*).
In pairs, alternately crossing.

Dehiscence (*dehisco*, L. I gape).
Splitting into regular parts.

Diaphanous (*dia*, Gr. through, + *phaino*, I show).
Nearly transparent.

Dichotomous (*dichotomos*, Gr. divided in two).
Forked equally.

Diffluent (*diffluo*, L. I flow).
Readily dissolving.

Diœcious, Dioicous (*dis*, Gr. twice, + *oikos*, a house).
When the male organs are borne on one plant and the female on another.

Dissepiment (*dissepio*, L. I separate).
A partition or division.

Encysted (*en*, Gr. within, + *cystis*, a bladder).
Enclosed in a cyst or bladder.

Endochrome (*endon*, Gr. within, + *chromos*, colour).
Cell contents. Colouring matter of cells.

Endophytal (*endon*, Gr. within, + *phyton*, a plant).
Growing within plants.

ENDOSMOSE (*endon*, Gr. within, + *osmos*, impulsion).
The inward current established between fluids of different densities when separated by a membrane.

ENDOSPORIUM, ENDOSPORE (*endon*, Gr. within, + *spora*, a spore).
The inner coating of a spore.

EPIGYNOUS (*epi*, Gr. upon, + *gўne*, a female).
Seated upon the female organ.

EPIPHYTAL (*epi*, Gr. upon, + *phyton*, a plant).
Growing upon plants.

EPISPORE (*epi*, Gr. upon, + *spora*, a seed).
The outer integument of a spore.

EPIZOIC (*epi*, Gr. upon, + *zōon*, an animal).
Growing upon animals.

EXOSPORIUM, EXOSPORE (*exo*, Gr. outwards, + *spora*, a spore).
The outer membrane of the coat of a spore.

FASCICLE (*fascicula*, L. a little bundle).
A bundle.

FASCICULATE (*fascicula*, L. a little bundle).
In bundles from a common point.

FILAMENTOSE (*filum*, L. a thread).
Composed of threads. Thread-like.

FOLIACEOUS (*folium*, L. a leaf).
Resembling a leaf.

FURFURACEOUS (*furfur*, L. bran).
Mealy, or resembling meal.

GEMINATE (*gemini*, L. twins).
Produced in pairs.

GENUFLEXUOUS (*genu*, L. a knee, + *flecto*, I bend).
Bent angularly like a knee joint.

GONIDIA (*gonē*, Gr. offspring, seed, + *eidos*, resemblance).
Propagative bodies of small size not produced directly or indirectly by any act of fertilization.

GONOSPHERE (*gonos*, Gr. seed, + *sphæra*, a ball).
A ball-like agglomeration of spores.

GYNANDROSPOROUS (*gyne*, Gr a woman, + *anēr*, a man).
Bearing male and female spores.

HAMATE (*hamus*, L. a hook).
Hook-shaped, resembling a hook.

HETEROCYST (*heteros*, Gr. diverse, + *cystos*, a bladder).
Intercalated cells of a special character differing from their neighbours.

HETEROGENOUS (*heteros*, Gr. another, + *gĕnos*, race, family).
Unlike, or dissimilar in kind.

HEXAHEDRICAL (*hex*, Gr. six, + *hedron*, a side).
Having six sides.

HOMOGENOUS (*homos*, Gr. alike, + *genos*, race, family).
Of the same kind. Consisting of elements of a like nature.

HORMOGONE (*hormos*, Gr. a necklace, + *gŏnē*, offspring).
Special reproductive bodies, composed of a chain of cells.

HYALINE (*hyalos*, Gr. glass).
Transparent, resembling glass.
HYPNOSPORANGIUM, HYPNOSPORANGE (*hypnos*, Gr. sleep).
Sporangium enclosing hypnospores.
HYPNOSPORE (*hypnos*, Gr. sleep + spore).
Spores which repose some time before germinating = "resting spores."
HYPOGYNOUS (*hypo*, Gr. under, + *gўne*, a woman).
Seated beneath the female organ.
IDIO-ANDROSPOROUS (*idios*, Gr. proper, + androspores).
Neuter individuals, producing androspores (in *Œdogonium*).
INTERCALATED (*inter-calare*, L. to insert in the calendar).
Interspersed, placed between others.
INTERCELLULAR (*inter*, L. between, + cellular).
Between the cells.
INTERSTITIAL (*interstitium*, L. a space between).
Placed between.
ISOLATED (*insŭla*, L. an island, through the Italian *isola*).
Detached, placed by itself.
ISOSPORE (*isos*, Gr. equal, + *spora*, a seed).
Applied to spores which are all of one size, or kind, in the same plant.
LACUNA (*lacuna*, L. a little hole).
A depression, cavity, or intercellular space.
LAMELLÆ (*lamellæ*, L. thin plates of metal).
Thin plates or membranes parallel to each other.
LAMELLOSE (*lamellæ*, L. thin plates of metal).
Formed of layers or plates superimposed.
LUBRICOUS (*lubricus*, L. slippery).
Slippery.
LUNATE (*luna*, L. the moon).
Crescent-shaped.
MACRANDROUS (*macros*, Gr. large, long, + *aner*, a man).
Having elongated male plants.
MACROGONIDIA (*macros*, Gr. large, long, + gonidia).
Large gonidia.
MATRICAL (*matrix*, L. the womb).
Belonging to the matrix.
MESOPHYLLIC (*mesos*, Gr. middle, + *phyllos*, a leaf).
In the middle of a leaf or frond.
MESOSPORIUM, MESOSPORE (*mesos*, Gr. middle, + *spora*, a spore).
The middle membrane of the coat of a spore.
METAGENESIS (*meta*, Gr. after, + *gĕnĕsis*, origin).
A kind of alternation of generations.
MICROGONIDIA (*micros*, Gr. small, + gonidia).
Small gonidia.
MICROPYLE (*micros*, Gr. small, + *pylē*, gate).
The aperture in the skin of a seed which was the foramen in the ovule. A little scar.

MOBILE (*mobilis*, L. movable).
Movable.
MONILIFORM, (*monile*, L. necklace, + *forma*, shape).
Necklace-shaped, contracted at regular intervals.
MONOICOUS, MONŒCIOUS, (*monos*, Gr. one, + *oikos*, a house).
With male and female organs on the same plant.
MULTICELLULAR (*multus*, L. many, + *cellula*, a little cell).
Composed of many cells.
MULTILOCULAR (*multus*, L. many, + *loculus*, a little place).
Containing many cells or cavities.
MULTI-PARTITE (*multus*, L. many, + partite).
Divided into many parts.
NANANDROUS (*nanos*, Gr. a dwarf, + *aner*, a man).
Having short or dwarf male plants.
NODULOSE (*nodŭlus*, L. a little knot).
Knotted, or with swollen joints.
NUCLEUS (*nucleus*, L. a kernel).
The central germ around which a cell is formed. Small spherical bodies contained within spores or other cells.
OBCORDATE (*ob*, L. inversely + *cor*, the heart).
Inversely heart-shaped.
OCTONATE (*octo*, Gr. eight).
Eight together.
OLEAGINOUS (*oleaginus*, L. of an olive tree).
Oily, or resembling oil.
OÖGONIUM (*oön*, Gr. egg, + *gŏnos*, seed).
A kind of ovarian sac containing spores which, when liberated, are called oospores.
OÖSPORE (*oön*, Gr. an egg, + *spora*, a seed).
Spores produced in an ovarian sac.
OPERCULUM (*opercŭlum*, L. a cover or lid).
The lid or cover of a capsule.
PARENCHYMA (*parenchȳma*, Gr. anything poured in beside).
Compressed or hexagonal cellular tissue.
PARENCHYMATOUS (*parenchȳma*, Gr.).
Resembling the cellular tissue termed "parenchyma."
PARIETAL (*paries*, L. a wall).
Growing by, or to, the wall.
PARTHENOGENESIS (*parthenos*, Gr. virgin, + *genesis*, origin).
Production of fertile seeds without sexual impregnation.
PARTHENOGONIDIA (*parthenos*, Gr. a virgin, + gonidia).
Gonidia produced without fecundation.
PATENT (*pateo*, L. I am open).
Spreading.
PECTINATE (*pecten*, L. a comb).
Pinnatifid, with narrow close segments, like the tooth of a comb.
PEDICELLATE (*pediculus*, L. a little foot).
Having a foot, or stem.

PENTAHEDRICAL (*pente*, Gr. five, + *hedron*, a side).
Having five sides.
PERICARPIUM (*peri*, Gr. around, + *carpos*, a fruit).
Covering or tegument of fruit.
PERIDERM, PERIDERMIC (*peri*, Gr. around, + *derma*, skin).
The enclosing membrane.
PERIPHERAL (*peri*, Gr. around, + *phero*, to carry).
The outer portion of a circle.
PILIFEROUS (*pilus*, L. a hair, + *fero*, I bear).
Bearing hairs, hairy.
PLICATE (*plica*, L. a plait).
Folded, or plaited.
PLUMOSE (*pluma*, L. a feather).
Feathery, or like a feather.
POLYMORPHISM, POLYMORPHIC, (*polus*, Gr. many, + *morphos*, form).
Having many forms.
PRIMORDIAL (*primordium*, L. beginning).
Original, existing from the beginning.
PROTHALLUS (*pro*, Gr. before, + *thallus*, a frond).
The false thallus first formed on germination of a spore.
PSEUDO-BRANCHES (*pseudos*, Gr. false, + branches).
False branches, or resembling branches.
PSEUDO-RAMOSE (*pseudos*, Gr. false, + *ramus*, a branch).
Having false branches.
PYRIFORM (*pyrus*, L. a pear, + *forma*, form).
Pear-shaped.
QUADRI-RADIATE (*quadrum*, L. four-square, + radiate).
With four radii, or rays.
QUATERNATE (*quater*, L. four times).
Arranged in fours.
RAMULUS (diminutive of *ramus*, L. a branch).
A small, or secondary branch.
RENIFORM (*renes*, L. the kidneys, + *forma*, shape).
Kidney-shaped.
REPLICATE (*re*, L. back, + *plico*, I fold).
Folded back.
RESTING-SPORE. A spore which becomes quiescent, or rests for a period, more or less long, before germination.
RHIZOID (*rhiza*, Gr. a root, + *eidos*, resemblance.)
Resembling, or analogous to, a root.
ROSTRATE (*rostrum*, L. a beak).
Terminating with a beak.
SACCATE (*saccus*, L. a sac).
In the form of a bag.
SCALARIFORM (*scula*, L. a ladder, + *forma*, shape).
Barred or crossed like the steps of a ladder.

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Scrobiculate (*scrobiculus*, L. a little ditch).
Marked with little pits or depressions.

Scutate (*scutum*, L. a shield).
Buckler-shaped.

Segmentation (*segmentum*, L. a segment).
Dividing into segments.

Segregate (*segrego*, L. I separate).
To separate from others, or set apart.

Semi- (L. half).
Prefix signifying "half."

Septum (*septum*, L. a hedge).
A partition or division.

Sigmoid (*sigma*, Gr. the letter S).
Shaped like the letter S.

Sinus (*sinus*, L. a hollow).
A depression or notch.

Spermatozoa, Spermatozoids (*sperma*, Gr. a seed, + *zoön*, an animal).
Thread-like bodies possessed of motion, supposed to have fecundative power.

Sporangium, Sporangia (*spora*, Gr. a seed, + *angos*, a vessel).
A spore-case, having spores produced within it.

Sporiferous (*spora*, Gr. a seed, + *fero*, I bear).
Bearing spores.

Sporocarpium (*spora*, Gr. a seed, + *carpos*, a fruit).
Covering or capsule enclosing spores, or carpospores.

Sporoderm (*spora*, Gr. a seed, + *derma*, a membrane.
The coating or covering of a spore.

Sporules (diminutive of spore).
Minute spore-like bodies.

Stratose (*stratum*, L. a couch or bed).
Arranged in layers or strata.

Stratum (L. a couch or bed).
A layer, or extended bed.

Striæ (*stria*, L. a groove or furrow).
Parallel lines or shallow grooves.

Sub- (L. under).
A common prefix indicating "almost" or "nearly."

Subulate (*subula*, L. an awl).
Shaped like an awl.

Tangential (*tangens*, L. touching).
In the direction of a tangent. Touching a straight line on the arc of a circle.

Tegument (*tego*, L. I cover).
A covering or membrane.

Terete (*teres*, L. long, round, and tapering).
Cylindrical, tapering like the trunk of a tree.

Tetrahedrical (*tetra*, Gr. four, + *hedron*, a side).
Having four sides.

TETRASPORES (*tetra*, Gr. four, + spores).
Certain spores produced in fours.

THALLUS (*thallos*, Gr. a frond).
An expansion somewhat resembling a leaf.

TORULOSE (*torulus*, L. a little cord).
Almost synonymous with moniliform.

TRICHOGONIA (*thrix*, Gr. the hair, + *gonos*, generation).
The female reproductive organs in Batrachosperms.

TRICHOME (*thrix*, Gr. the hair).
The thread or filament of filamentous algæ.

TRICHOTOMOUS (*tricha*, Gr. threefold, + *temno*, I cut).
Dividing in threes.

TRUNCATE (*truncus*, L. a stump).
Terminating very abruptly.

TUBERCULATE (*tuberculum*, L. a pimple).
Covered with warts or tubercles.

UNICELLULAR (*unus*, L. one, + *cella*, a cellar).
Literally, composed of one cell.

VACUOLE (*vacuus*, L. empty).
Drops which are seen in the interior of the protoplasm of cells.

VAGINA, VAGINATE (*vagina*, L. a sheath).
A sheath, sheathing.

VERRUCOSE (*verruca*, L. a wart).
Covered with warts.

VERTICILLATE (*verticillus*, L. a whorl).
Arranged in whorls.

VESICLE (*vesicula*, L. a little bladder).
A bladder-like cavity.

VIBRATILE (*vibro*, L. to quiver or shake).
That moves to and fro, or vibrates.

ZOÖGONIDIA (*zoön*, Gr. animal, + gonidia, which see).
Gonidia endowed with active motion.

ZOÖSPORANGIUM, ZOÖSPORANGE (*zoön*, Gr., an animal, + sporangium).
Sporangium enclosing zoospores.

ZOÖSPORES (*zoön*, Gr. an animal, + *spora*, a spore).
Locomotive spores.

ZYGOSPORE (*zygos*, Gr. a yoke, marriage, + spora).
A spore resulting from conjugation.

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